JUL 7 1925

JULY, 1925 VOLUME 31 NUMBER 11

MACHINERY

THE INDUSTRIAL PRESS Publishers, 140-148 LAFAYETTE ST., NEW YORK

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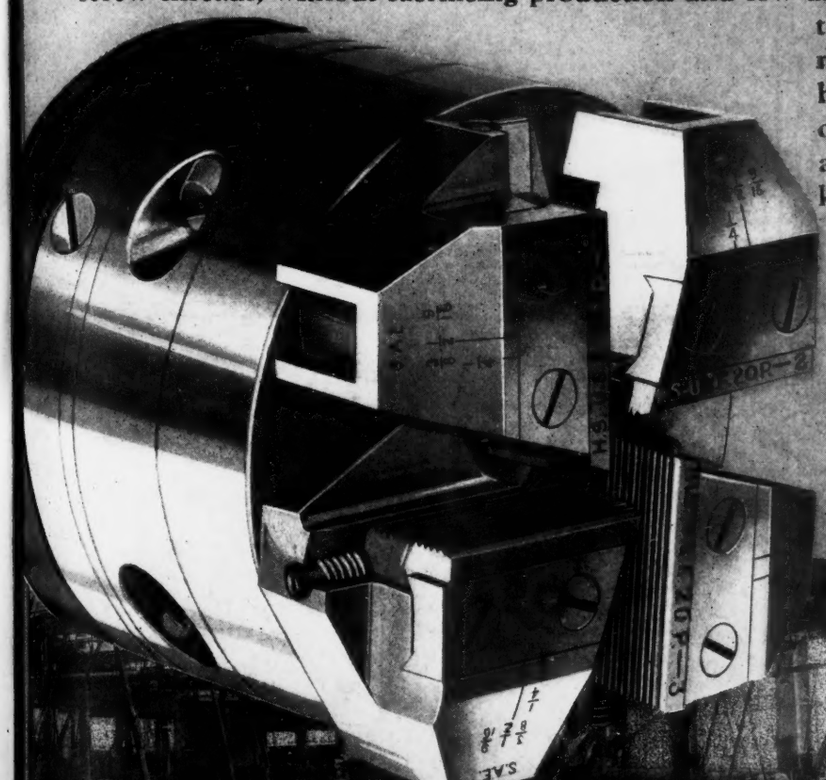
The Lanco, Rotary Type, for use on all automatic and hand operated thread cutting machines. This new series of the Landis line meets the present exacting standards for screw threads, without sacrificing production and low die cost. It is 40% smaller than the standard Landis die head—made of high grade steel and heat treated throughout; no openings to catch dirt or chips and is equipped with the well known Long Life Landis Chaser.



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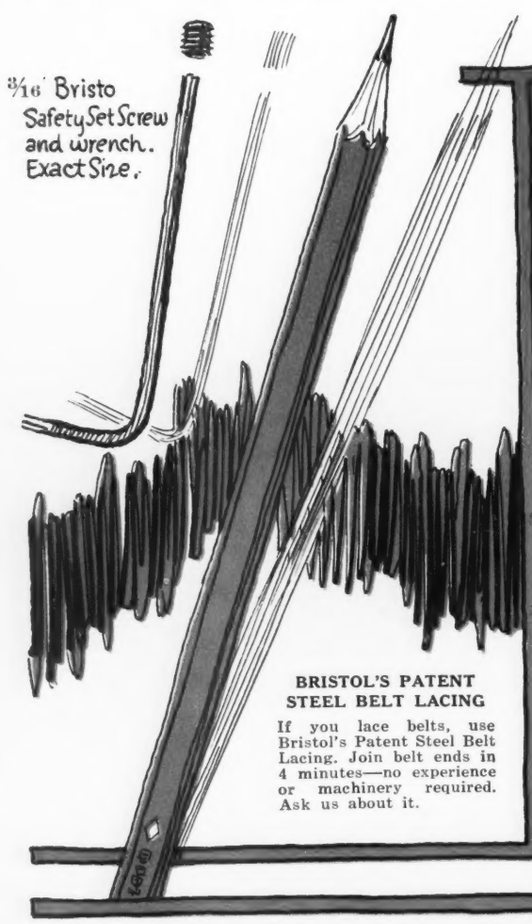

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"Bristo" Safety Set Screws in 1/8" and 3/16" sizes are as sturdy as solid set screws, either while being tightened or under the strains of service. So why stick to the solid set screws for the smaller sizes?

BRISTO SAFETY SET SCREWS

These smaller sizes of hollow set screws are not used as much as they should be, the impression persisting that they are not as reliable as solid screws. This is not true of "Bristo" Safety Set Screws. They are made of specially heat-treated steel that will not split, and the patented dovetailed flutes give the wrench a grip on the screw that *actually holds the screw together!*

We recommend and guarantee "Bristo" Safety Set Screws in 1/8" and 3/16" sizes. They are just as satisfactory as the larger sizes. May we send samples for your inspection? Ask for bulletin 811E.

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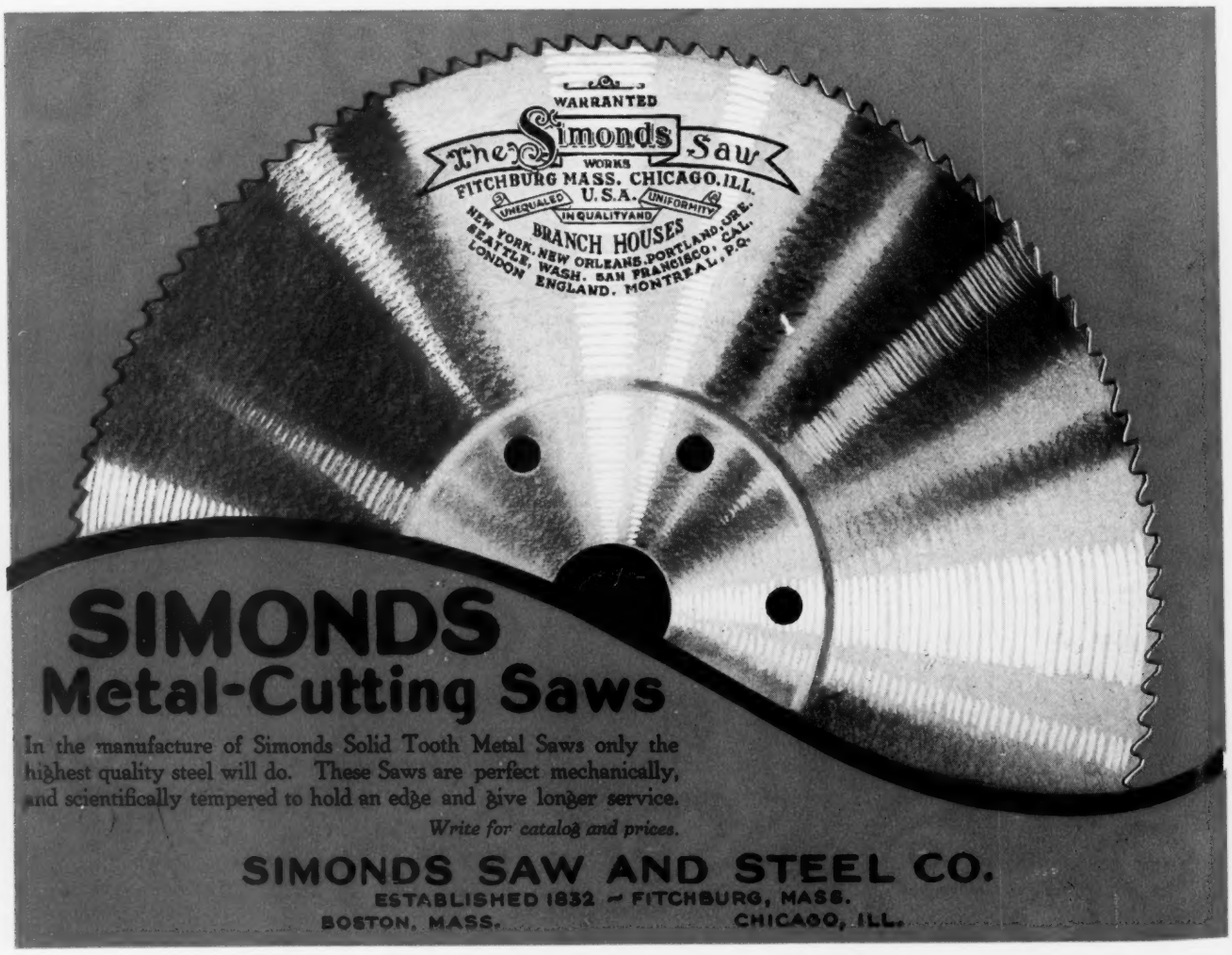
Waterbury, Conn.

MACHINERY



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Training Machinists in the Reo Plant

How a Large Automobile Company Maintains its Supply of Skilled Machinists by Conducting Apprenticeship Courses

By CHARLES O. HERB

IT is often stated that automobile plants draw their skilled machinists from other industries, without doing anything themselves to train men, but there are a few automobile plants to which this does not apply. The Reo Motor Car Co., Lansing, Mich., is an outstanding example in this respect. This company conducts extensive courses which give apprentices a well rounded education in the machinist trade and train them definitely either to become toolmakers or to fill positions in the manufacturing departments. The methods used in training the boys are unique in a number of respects, and they have proved most satisfactory. Similar methods could well be adopted not only by other automobile plants, but by any type of machine building shop. For this reason the features of the Reo apprentice system will be described in this article.

The number of apprentices is limited to 200, and classes are formed at any time to keep the number as close as possible to this maximum amount. It is an interesting fact that while applications are accepted only every two months and then only from boys that appear to be desirable, there are always more than 150 live applications on hand from which classes can be formed as others graduate or a sufficient number of vacancies occur. In the three years that have elapsed since applications have been filed, there have been 982 applications. This large number is evidence of

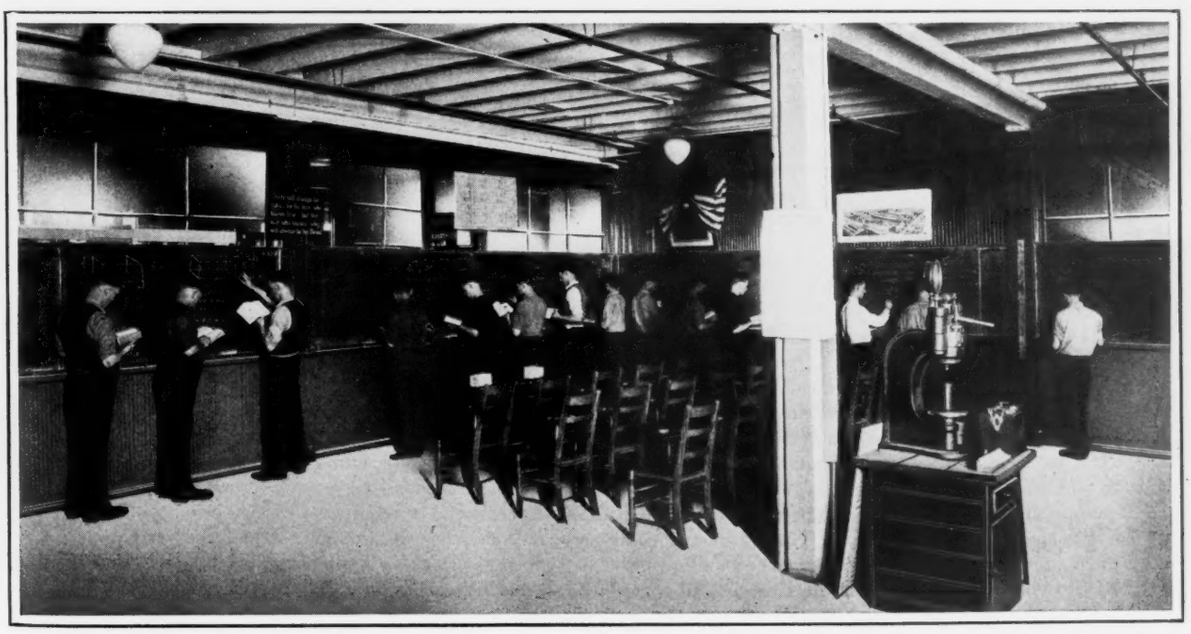


Fig. 1. Typical Class solving Problems by the Use of Formulas, Tables and Other Information in MACHINERY'S "Handbook"

the esteem in which the courses are held by the community.

Three Different Classes of Apprentices

Many shops limit apprenticeships to boys younger than twenty years, but in the Reo plant young men up to twenty-five years of age may start learning the machinist trade. This opens the course to young men who for various reasons could not start learning a trade when they first left school. Because of the large range of ages and the differences in education, it has been found desirable to divide the apprentices into three classes. One of these classes is open to young men from twenty-one to twenty-five years old who have gone through eight or more grades of school. The length of this course is two years, and the wage throughout the course is 40 cents per hour.

The next class is for young men from eighteen to twenty-one years old who are high school graduates. This course covers two and one-half years, and the wages range from 30 to 40 cents per hour. The third class is for boys from sixteen to twenty-one years old who have gone through eight or more school grades, and lasts four years. The wages for this class range from 22 1/2 to 40 cents per hour. The average age of apprentices is twenty-one and a half years. Out of 190 apprentices enrolled at present, 94 are in the senior group, and 75 are high school graduates.

Applications for apprenticeships are made through the regular employment department so that the boys are immediately made to feel that they become a definite part of the Reo organization when they are accepted. Boys are advised against making an application unless they seriously plan to follow the machinist trade, and are warned that they cannot expect to be transferred to another department after they have once signed an agreement. They are also informed that they will be required to do a certain amount of home work in mathematics, and that they must buy text-books and an outfit of tools that will cost from $75 to $100. The tools, of course, can be bought gradually.

After an applicant is accepted, he serves a probationary period of about three months in the apprentice department before he is asked to sign a contract. This gives the company an opportunity to judge the worth of the boy and permits the boy to obtain a good idea of the trade. The agreement is sworn to before a notary public so as to impress the applicant with the seriousness of the step he is taking. The agreement specifies in detail the training and the wages that the apprentice will receive up to the end of the course, and it is dated to cover the trial period of three months.

Machinery's Handbook Used as a Text-book

Perhaps the most unique feature of the courses is the use of a standard handbook as a text-book in the classroom and for the home work. Machinery's Handbook was found most suitable for this purpose, as it covers mathematics, strength of materials, gear and machine design, and all other phases of the machinist trade. Fig. 1 shows a typical class working out problems directly from formulas and tables in the Handbook. The work based on the Handbook is termed "Machine Shop Essentials." Each group of apprentices spends five hours a week in the classroom, three of which are ordinarily devoted to drawing.

During the first six months of their courses, some time is also given to instructing the boys in laying out on metal. Home work in problems solved by the use of the Handbook requires about two hours a week on the part of the average apprentice. In a conspicuous place in the classroom there is a motto intended to instill in the boys the desire to apply themselves assiduously to their courses. This motto reads, "There will always be a place for the man who knows how—but the man who knows *why* will always be his boss."

Machinery's Handbook is used for all classes, but all students are first given six months' training in arithmetic from a text-book that covers fractions, decimals, weights and measures, percentage, ratio and proportion, powers and roots, etc. This preliminary work gives a foundation for the practical problems of the classroom during the remainder of the course. The work based on the Handbook is divided into three parts that cover six or seven month periods each, and every lesson is divided into three sections. Section A consists of a discussion of points concerning the lesson that may not be described fully in the Handbook and that will assist the student to obtain a better understanding of the subject; section B consists of a number of problems that are worked out on the blackboard by using formulas and tables in the Handbook; and section C contains problems that must be worked out at home and turned in for correction.

The lessons are either printed or multigraphed on sheets that can be easily inserted in a loose-leaf folder. Fig. 2 shows a portion of a lesson on shop trigonometry from section A. By reading the first paragraph of the lesson one can readily see how closely it is tied up with the Handbook.

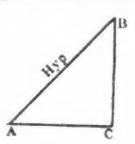
Part 1 -- Lesson 19

SUBJECT: SHOP TRIGONOMETRY; SPIRALS; EXERCISES

A. The terms helix and spiral are quite frequently confused in shop calculations. From the illustration on page 280 it can be seen that every point on the helix is equidistant from the axis. A comparison of a helix and a spiral can be seen on page 451. Every point on a spiral is at an unequal distance from the axis of the spiral. Shop usage however has sanctioned the use of the term spiral where frequently helical is intended. Unless otherwise specified the spiral angle is taken from the axis of the gear, reamer or other part having spiral form. As an example, notice the spiral angles on page 711. One exception to the foregoing is the case of thread angles. These angles are calculated from a plane perpendicular to the axis of the threaded part. See page 940.

If a piece of paper is cut in the form of a right triangle and wrapped around a cylinder, the hypoteneuse will form a helix similar to a screw thread. From the properties of a right triangle, simple formulas can be derived which govern all spiral angles. With spirals in general, the circumference of the part divided by the lead equals the tangent of the angle or tan $a = c/(1)$. For screw threads this becomes tan $a = L/c$. Solving the first equation we get: $c = \tan a \times L$ (2) and $L = c \div \tan a$ (3).

Another method of solving triangles will now be explained. This method is recommended when dealing with problems involving four or five place decimals or when long tedious multiplications or divisions would seem necessary. Refer again to the explanation on page 224. The following rules involving logarithms, are developed from the method previously explained.



To find the side opposite an angle when the hypoteneuse and angle are known,

$$\frac{S\ O}{Hyp} = \sin A \text{ or } S\ O = Hyp \times \sin A.$$

Therefore, log S O=log Hyp+log sin A.

The other rules are developed in a similar manner. In the solution of problems by this method the rules are taken directly from the following list and are not developed for each problem.

1. log S O=log Hyp+log sin A
2. log S O=log S A+log tan A
3. log S A=log Hyp+log cos A
4. log S A=log S O+log cot A
5. log Hyp=log S O—log sin A
6. log Hyp=log S A—log cos A
7. log sin A=log S O—log Hyp
8. log cos A=log S A—log Hyp
9. log tan A=log S O—log S A
10. log cot A=log S A—log S O

These rules are sufficient for all ordinary problems, but many other trigonometric formulas could readily be changed to this form if desired.

Fig. 2. Portion of Section A of a Lesson in Shop Trigonometry

The superintendent of apprentices states that it has been much easier to make the student grasp trigonometric and geometric problems by the use of the HANDBOOK than when standard school text-books were used, because it is easier to make him understand the practical application of mathematics in his trade. For the home use of the apprentices a library is maintained containing about sixty-five volumes, included in which are MACHINERY'S ENCYCLOPEDIA and twenty-nine volumes of MACHINERY'S books on shop and drafting-room practice.

Part 1 of "Machine Shop Essentials" covers powers, roots and reciprocals; squares and cubes of mixed numbers; circumferences and areas of circles; fractions of Pi; tables of chords; table of polygons; spacing off circumferences; areas and volumes of spheres; volumes of spherical segments; logarithms; shop geometry and trigonometry; radians; solution of equations, etc. Part 2 covers such subjects as tapers; screw thread systems; measurement of screw threads; taps and threading dies; bolts and nuts; gears of all types; cams; clutches and couplings; machine tool drives, etc. Part 3 covers steel and its heat-treatment; inspection; drilling; milling; lathe work; grinding; shaping and planing; broaching; gear-cutting; punches and dies; forging; welding; soldering; and the operation of automatic screw machines. Part 4 has not been entirely developed, but it will cover such subjects as feeds and speeds; jigs and fixtures; gages; lubricants; and patterns.

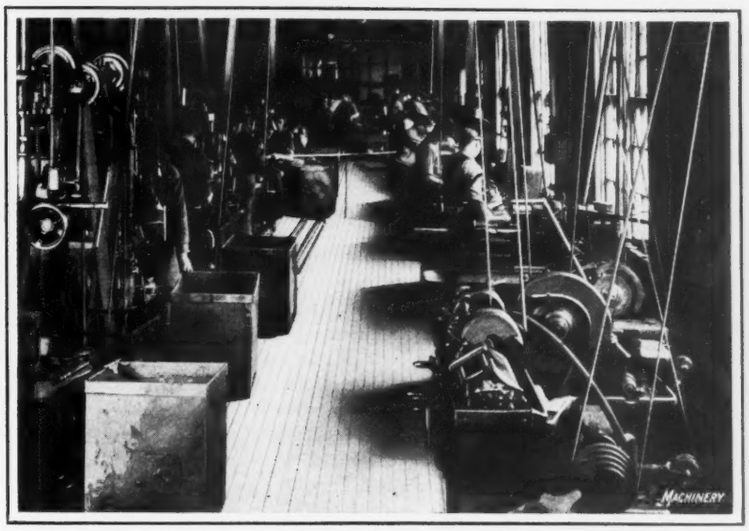


Fig. 3. General View of the Apprentice Machine Shop

Various problems that have come up in the shop, requiring the use of mathematics, are given to the students in blueprint form for them to work out. Two such examples are shown in Fig. 4; at the left is a sectional view of a sleeve plunger, the dimension *X* of which must be determined from the given dimensions. The example shown at the right is a gage used to check the face angle of a ring gear. Dimension *Y* must be calculated from the angles and the dimensions given.

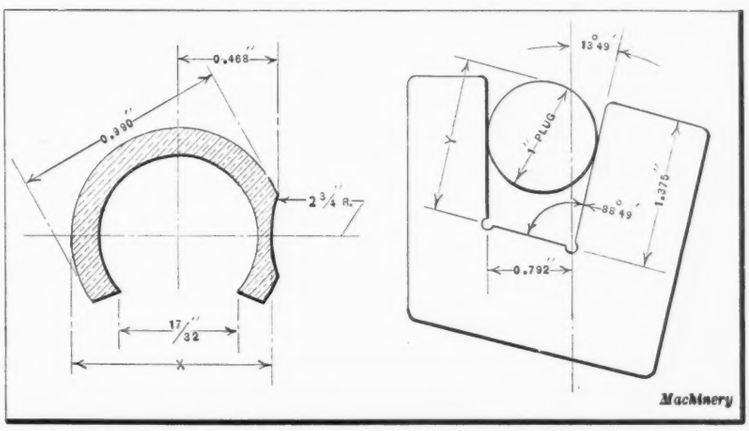


Fig. 4. Two Examples of Practical Problems such as the Apprentices are required to solve from Blueprints

An understanding of the practical application of mathematics to his work is the first advantage obtained by the apprentice from using MACHINERY'S HANDBOOK in the school room. Another advantage is that by its constant use the apprentice familiarizes himself with the HANDBOOK so that later in his practical work he will be able to readily make use of the information contained in it and obtain the maximum benefit from it.

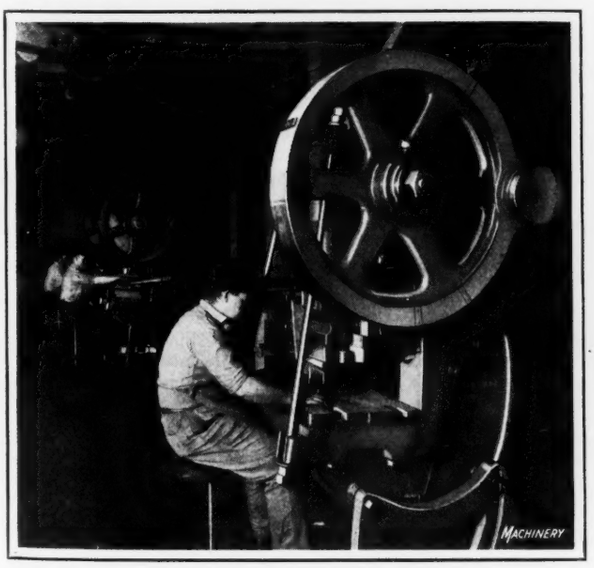


Fig. 5. Three Power Presses in the Apprentice Machine Shop which the Boys are taught to set up and operate

Drafting and Lay-out Work

In the drawing period of the classroom work, the apprentices follow a course carefully outlined to meet the needs of machinists. Particular stress is laid on the making of clear and complete sketches, and the work is correlated as far as possible with the "Machine Shop Essentials." Drawings are not usually inked in, as it is not the object to develop draftsmen; the intention is only to train the boys to make good sketches and to read blueprints easily. Occasionally when a boy is found to have exceptional talent for drawing, he is transferred to the drafting department.

During the first six months of his course, each apprentice spends two hours of his weekly period in learning to lay out work to actual scale from drawings. This teaches him not only to use such instruments as scribers, height and surface gages, gage-blocks, dividers, protractors, etc., but also to work from drawings of small scale. At first the boys are taught to lay out on white painted boards 12 by 8 inches in size, so as to save expensive material, but after they have learned the use of the instruments and the necessity of being careful, they lay out on castings and other parts that are actually passed through the manufacturing departments of the shop. In this department, each boy is provided with a 19- by 36-inch surface plate and an angle plate, and there is an ample supply of the smaller instruments.

Outline of the Shop Work

New boys are first sent to the apprentice machine shop, where they are given a preliminary training in the operation of the various types of machines. There are about sixty machines in the shop and different machines of the same types are included so that the boys will become familiar with more than one make. Thus there are Brown & Sharpe, Milwaukee, Cincinnati, and Kempsmith milling machines. In addition to the types of machines usually found in apprentice departments, there are a number of automatic screw machines, so that the boys may learn to set up the cams and tools on such machines and to operate them. There are also three power presses, as shown in Fig. 5, which the boys are taught to equip with dies and to operate. The preliminary training in this department lasts about two months.

When the preliminary training has been completed, the boys are sent to the different departments of the shop, where they spend varying periods of time on different kinds of work, as indicated on the certificates shown in Figs. 6 and 7. Wherever Mr. Avis' name appears in the column headed "Foreman" in these illustrations, the apprentice machine shop is implied. These illustrations show the work given to the average apprentice, but if he should possess particular ability for toolmaking, his work is arranged to keep him in the tool-room for a large portion of his time.

While the boys are in the shop they may be returned to the apprentice machine shop at any time when production falls off in the shop or for other reasons. This department also supplies the regular shop departments with apprentices to fill the places of men absent for a day or a short period of time. Near the end of their courses the apprentices spend at least six months in the apprentice machine shop so that finishing touches may be put on their shop experience. When a boy has completed his course, a certificate such as illustrated in Figs. 6 and 7 is made out in quadruplicate. One of these is given to the boy, one filed in the apprentice department, one kept by the employment department, and the fourth retained by the factory superintendent. The boy is also given a diploma signed by the factory manager and the superintendent of apprentices.

Keeping the Apprentice Machine Shop Supplied with Work

The number of boys in the apprentice machine shop at one time averages forty-five, and so a considerable quantity of work must be routed through this department to keep it busy; however, it has been found easy to do this. When newly designed automobile parts are started through the shop, they are frequently routed to this department for manufacture until jigs can be made up for handling them in the regular shop departments. Many parts on which lay-out work is necessary are always handled here, as well as screw machine products required in lots of from 2000 to 3000. Automobile repair parts for cars of old design constitute a considerable portion of the work, and about eight boys are kept busy on making machine repair parts. Special machines are sometimes built, as for instance, several vertical type machines used for polishing metal pieces to be photomicrographed. Many tools are salvaged by grinding down to smaller sizes. All work is checked by an inspector who is directly responsible to the inspection department, and is in no way connected with the apprentice department.

Does the Apprentice Department Pay for Itself?

Although it has never been actually determined, it is believed that the work done by the apprentices actually pays the cost of carrying on the apprentice program. However, there is no doubt that the department pays for itself by keeping the shop filled with men skilled on all standard machine tools. This is an important fact because the foreman and sub-foreman of the modern automobile shop must understand the operation of a variety of machines if they are to be efficient, because they generally have several types of machines under their charge. It was different in days gone by when all milling operations were performed in one department, grinding operations in another, planing operations in another, etc. With the constant supply of skilled men on hand, it is an easy matter to select new foremen as they are required, and they are chosen as often as possible from the ranks of the graduate apprentices.

It is the belief of the employment department that the apprentice courses tend to keep the percentage of labor turnover down, and it is interesting to note in this connection that the labor turnover of the Reo plant for the year 1924 was only 19.9 per cent, which is believed to be the lowest of any plant in the automobile industry. In order to insure that a large percentage of the graduate apprentices will continue to work in the Reo plant, local boys are favored first in granting apprenticeships and also the relatives of employes. Out of 166 graduates in the past eight years, 121, or 73 per cent, are still employed. The question naturally arises as to how many apprentices who successfully complete their three months' probationary period graduate from the course. The average is about 85 per cent.

REO MOTOR CAR COMPANY

APPRENTICE DEPARTMENT

TO WHOM THIS MAY COME:

This is to certify that John Doe

began his apprenticeship as Machinist

on April 22, 1922 Mr. Doe has carried work as indicated

below and completed his course as outlined on May 1st, 1925. Total number hrs. 7342

Type of Work	Dept. No.	Foreman	Dates	No. Months	
Arithmetic	120	Margeson	1923	6	
Geometry					
Trigonometry					
Handbook Part 1	120	Margeson	1922-23	6	Machinery's
Handbook Part 2	120	Amiss	1923	7	Machinery's
Handbook Part 3	120	Margeson	1923-24	7	Machinery's
Drafting	120	Bengry	1922-25	32	Class
Layout Work	120	Bengry	1922	6	Class
General Machine	103	Avis	1922	4	
Inspection	1206	Rounds	1922	2	
Drill Press	213	Green	1922	2	
Milling	213	Green	1923	2	Production
Milling	103	Avis	1923	2	Tool
Grinding	1201	Gardner	1923	3	Production
Gear Cutting	1202	Clark	1923-24	3	
Gear Cutting					
Lathe	1407	Burkett	1924	4	Crank&Cams
Lathe	103	Avis	1924	3	Tool
Shaper	103	Avis	1925	1	

Fig. 6. Front Side of a Certificate given to the Boy in Addition to his Diploma when he graduates as a Machinist

Why the Apprentice Program is Successful

The success of an apprentice system in any shop depends upon the attitude of the management. If the management is lukewarm toward it, the superintendents and foremen cannot be made to cooperate wholeheartedly, but if the management is behind the movement, the reverse is true. At the Reo plant the policy of the company toward the appren-

tice department is most liberal, and much personal interest is taken in the program by the officials. This could naturally be expected, since R. H. Scott (president and general manager), H. T. Thomas (chief engineer), H. C. Teel (factory manager), A. A. Lauzun (general superintendent), and George Rosa (tool-room superintendent) all served apprenticeships. Nearly all division superintendents and many foremen also have risen from the rank of apprentices. With such examples of possible advancement to hold before the boys, it is not difficult to make them interested in their work and proud of their trade. Then, too, it can be readily pointed out that in a company having over 6000 employes, there are plenty of opportunities for skilled men.

The faith of the officials in the apprentice department cannot be better illustrated than by mentioning that some

REO MOTOR CAR CO.
LANSING, MICHIGAN

Apprentice Department

A transcription of the record of

John Doe

200 hours represents one month

I hereby certify that this record is a true and complete statement

Supervisor Dept.

Dated May 4, 1925.

Type of Work	Dept. No.	Foreman	Dates	No. Months	
Planer					
Tool Crib					
Motor Assembly	1424	Adams	1924	3	Repair
Axle Assembly					
Bench Assembly	103	Avis	1925	1 1/2	
Chassis Assembly					
Final Assembly					
Sedan Assembly					
Testing and Checking					
Vulcanizing					
Heat Treat	1924	Hendra	1924	2	
Layout Work	1325	Perkins	1925	2	

Fig. 7. Reverse Side of the Certificate illustrated in Fig. 6 which shows in Detail the Training of the Graduate Apprentice

of their sons have graduated from the course and are working in the shop. Another factor in the success of the department is that every instructor has the rank of foreman in the Reo organization and receives an equivalent salary. Credit for carrying out the work successfully and for the preparation of the lessons based on MACHINERY'S HANDBOOK is given to John M. Amiss, superintendent of apprentices.

* * *

In order to expedite the work of standardization, the American Engineering Standards Committee has requested a committee of five well-known executives in American industry to act as an advisory committee on standardization problems. The advisory committee consists of J. A. Farrell, president of the United States Steel Corporation; G. B. Cortelyou, president of the Consolidated Gas Co.; J. W. Lieb, vice-president of the New York Edison Co.; L. F. Loree, president of the Delaware & Hudson Co.; and Gerard Swope, president of the General Electric Co.

RECUTTING OVER-SIZE GEARS

By S. W. BROWN

Gears that will not run freely together because the teeth are too thick on the pitch line or because they are not of the correct form may be recut quickly and accurately by a method known as "floating." The old method of filing teeth is a slow and inaccurate one, and recutting by indexing, the same as when cutting a new gear, is a slow process. Backlash and various conditions encountered in recutting gears often cause considerable trouble when using the indexing method.

The method of recutting gears by "floating" is simple and generally satisfactory. The gear is set up on a milling machine, the same as for cutting a new gear, except that there is no dog or driving device of any kind on the arbor on which the gear is mounted. Instead, the gear is free to be rotated by hand between centers. Care should be taken, however, to see that the gear is not too loose or shaky. The setting of the machine to cut the small amount necessary to correct the gears is made by trial. The spacing is done by rotating the gear by hand after each cut.

It is well for the beginner to start the cutter into the gear space before starting the machine spindle, but after a little practice the spindle may be kept running. The theory of the method known as "floating" is that the gear-cutter, having the same shape on each side, will cut an equal amount of material from each tooth, provided that the gear is not cramped in any way but is allowed to float or conform to any side motion of the gear-cutter. While the theory may or may not be sound, the method seems to work out well in practice. The writer has inspected hundreds of gears recut by the "floating" method, but has yet to see one that was unevenly spaced or spoiled in any way by the recutting operation. It might be mentioned that it is desirable to use a sharp gear-cutter when recutting gears by the method described.

* * *

USE OF MOTOR TRUCKS BY THE RAILROADS

The railroads are increasing the use of motor trucks as a substitute for rail freight service. The Chicago, Rock Island & Pacific Railroad has instituted a trucking service between Chicago and Auburn Park, Ill. The Michigan Central Railroad has inaugurated a similar service between Toledo, Ohio, and Monroe, Mich. The Pennsylvania Railroad has instituted trucking service between different freight houses in Detroit as a substitute for moving freight by rail between the different stations. Similar use of motor trucks by the same railroad has also been put into effect at Baltimore and Philadelphia. The Pennsylvania Railroad has been using trucks to replace local freight trains in many instances, for over two years.

* * *

The Carnegie Steel Co. has put in operation an idea for promoting interest in safety campaigns that is stated to have given very satisfactory results. A Safety Trophy is presented annually by the company. From month to month this trophy is held by the plant making the greatest reduction in lost-time accidents for the preceding month. At the end of the year the trophy is presented to the plant that has made the best record for the entire year. The trophy for 1925 is made from bronze, 21 inches high and 11 inches across the base, and was designed by a prominent Pittsburg sculptor.

Chart for Use in Designing and Milling Cams

BY HERBERT W. CABLE*

THE laying out of uniformly accelerated cams for automatic machinery often involves considerable figuring in order to obtain the specifications needed by the machinist to enable him to set up the milling machine properly. The chart shown in Fig. 1 is employed to determine the value of the units or increments to which the milling machine table must be set for each advance of the dividing head. This chart gives the required dimensions for any throw up to six inches and any number of divisions up to sixty. These dimensions pertain only to the part of the cam that produces the accelerated motion. The values for the remainder of the cam are obtained by simply reversing the order of the figures for the accelerating portion. The formula used in plotting the chart is derived as follows:

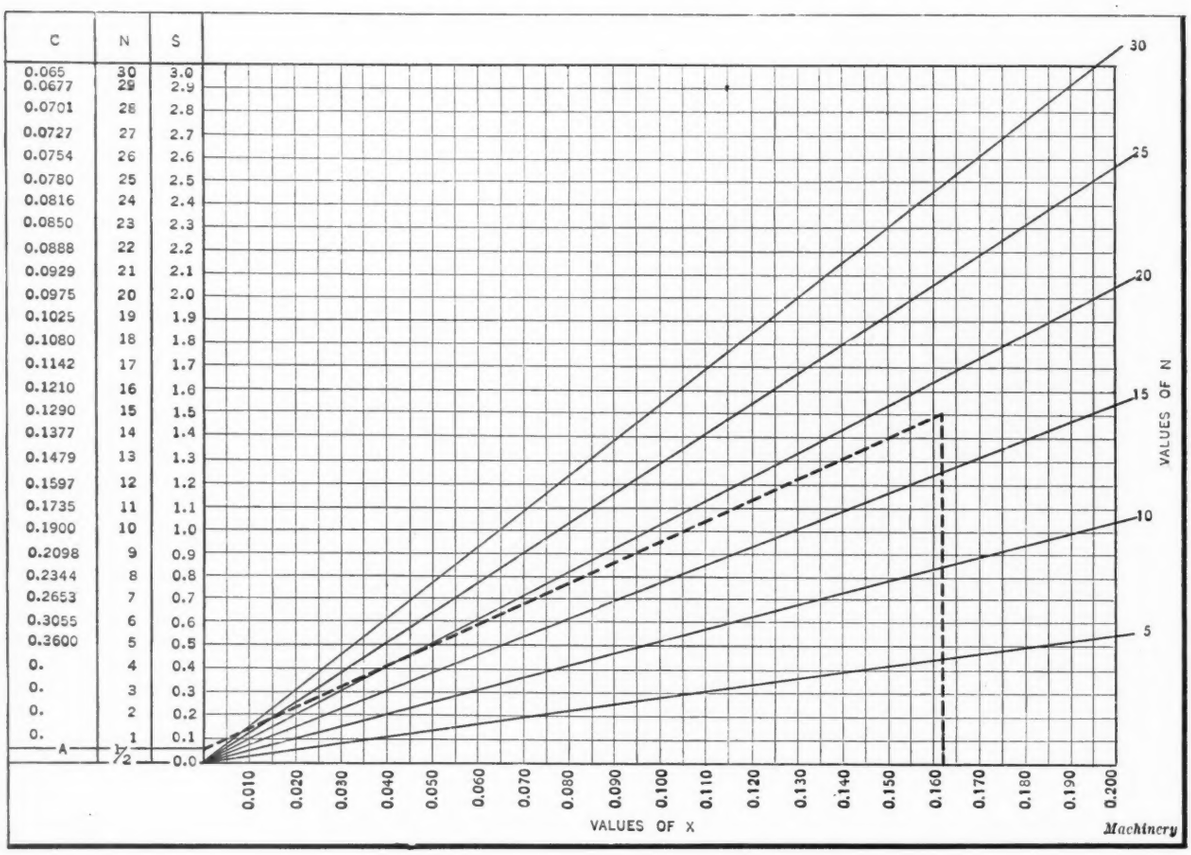


Fig. 1. Chart for determining Dimensions required in milling Cams

Let us consider the problem as involving two parallel arithmetical progressions, the first consisting of the quantities 1, 3, 5, 7, 9, etc., and the second consisting of the actual steps for advancing the milling machine table. In the first progression, let

S_1 = sum of quantities 1, 3, 5, 7, 9, etc.;

D_1 = difference = 2 in this case;

A_1 = first term = 1;

L_1 = last term = $A_1 + (N - 1)\ D_1$ (see MACHINERY'S HANDBOOK, pages 92 and 93 in the fifth edition and pages 102 and 103 in the sixth revised edition); and

N = number of terms.

In the second progression, let

S = one-half total throw of cam;

D = difference = $\dfrac{2S}{S_1}$;

A = first term or value of a single unit = $\dfrac{S}{S_1}$;

L = last term = $A + (N - 1)\ D$; and

X = any term.

Now

$$L_1 = A_1 + (N - 1)\ D_1$$

Substituting,

$L_1 = 1 + (N - 1)\ 2$ $\qquad$ $L_1 = 1 + 2N - 2$ $\qquad$ $L_1 = 2N - 1$

and

$$S_1 = \frac{N}{2}\ (A_1 + L_1)$$

(See MACHINERY'S HANDBOOK at section previously referred to.)

$$S_1 = \frac{N}{2}\ (1 + 2N - 1) \qquad S_1 = \frac{N}{2}\ (2N)$$

$$S_1 = N^2$$

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Hence the sum of the units is equal to the square of the number of divisions.

Now $A = \frac{S}{S_1}$; hence $A = \frac{S}{N^2}$ and $D = \frac{2S}{N^2}$. Therefore, the progression is as follows:

$$\frac{S}{N^2}, \frac{S}{N^2} + \frac{2S}{N^2}, \frac{S}{N^2} + \frac{4S}{N^2}, \frac{S}{N^2} + \frac{6S}{N^2} \text{ etc.}$$

Then

$$X = \frac{S}{N^2} + \frac{(2P-2)S}{N}$$

in which P equals the number of the term X or

$$X = S\,\frac{(2P-1)}{N^2}$$

of L are plotted for values of N equal to 5, 10, 15, 20, 25, and 30.

If the values of X for any throw and any number of divisions are plotted using column N, they will be found to be along a straight line which terminates at the value of L and at a point where $N = \frac{1}{2}$.

Method of Using Chart

The use of the chart is as follows: At the intersection of the horizontal line corresponding to one-half the required throw of the cam, and the diagonal line corresponding to the number of divisions, read the value of L at the bottom. Find the intersection of this vertical line with the horizontal line corresponding to the number of divisions in column N, and lay a straightedge on the chart connecting this point

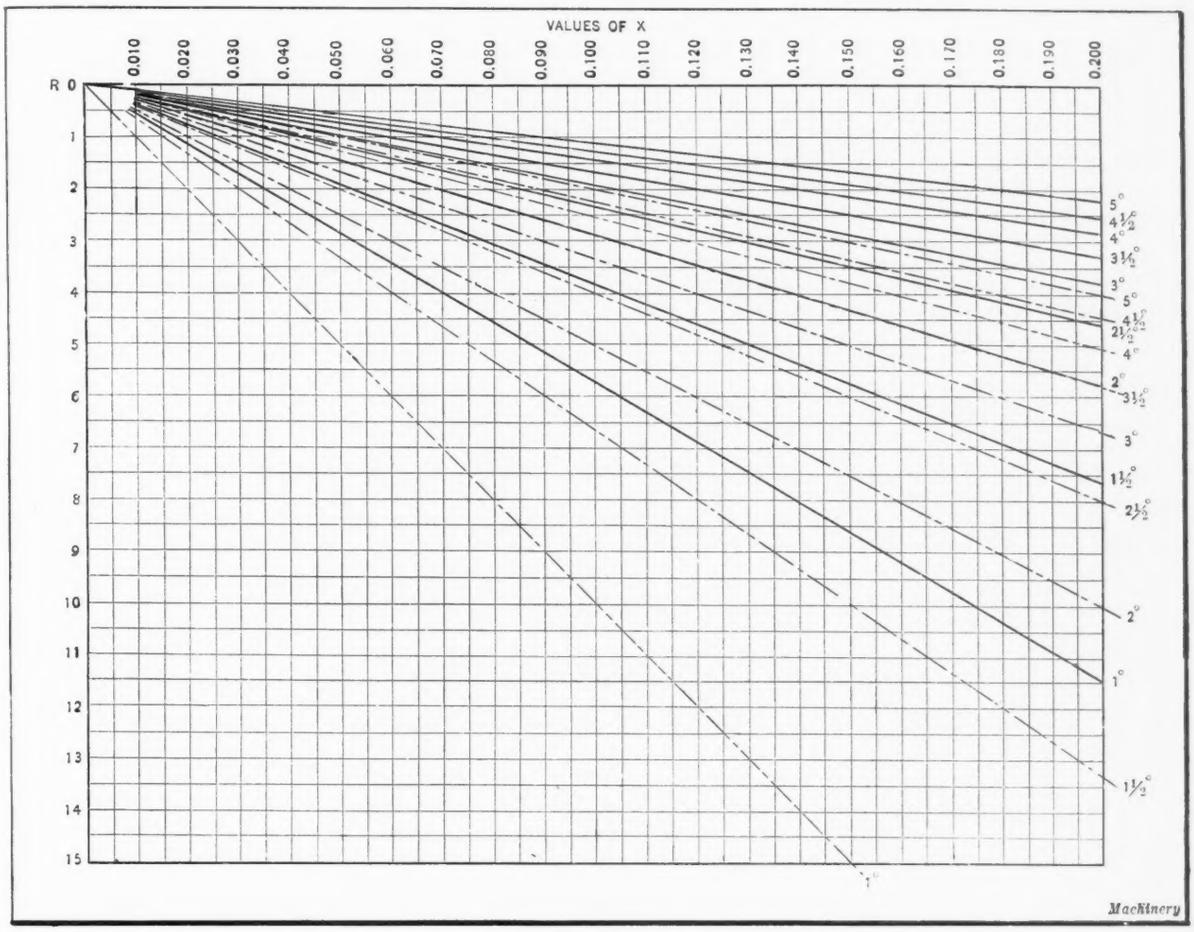


Fig. 2. Chart for finding Thrust Angle of Cams

and

$$L = \frac{S}{N^2} + (N-1)\,\frac{2S}{N^2}$$

Simplifying,

$$L = \frac{S}{N^2} + \frac{2SN-2S}{N^2} \text{ or } L = S\,\frac{(2N-1)}{N^2}$$

Let C = the constant $\frac{2N-1}{N^2}$. Then $L = SC$. If $N = \frac{1}{2}$, then $2N - 1 = 0$. Hence $X = 0$ when $N = \frac{1}{2}$.

Referring to the chart Fig. 1, in column C the values of the constant for each value of N from 5 to 30 are given. In column N are given the divisions from 1/2 to 30, and in column S are given the values of throws from 0 to 3 inches by increments of 0.1 inch. By using column S, the values

with the point A where $X = 0$ and $N = \frac{1}{2}$. Now read the values of each term X at each intersection with the horizontal line from each value under N. If this is done carefully, the readings will be found to be very accurate.

Example—It is desired to make a uniformly accelerated cam with a rise of 2 1/2 inches in 90 degrees. The radius is sufficiently small so that divisions of 3 degrees each will leave a comparatively small amount of metal to be removed by filing. This would give 30 divisions for a throw of 2 1/2 inches. As the cam will be accelerated over one-half the throw and retarded over the other half, we have 15 divisions for the value of N and 1 1/4 for the value of S.

Referring to the chart, under S we find the horizontal line for 1.250 and at the intersection with the diagonal line 15. We read down and find the last term is 0.162. Finding the value 15 under N, we locate the upper end of our straightedge at the intersection with the vertical line 0.162

and the lower end at the point A, we read the values of X at the intersections with lines 1, 2, 3, 4, etc., under N and make the following tabulations.

N	Units	X	Accumulative	N	Units	X	Accumulative
1	1	0.005	0.005	9	17	0.094	0.447
2	3	0.016	0.021	10	19	0.105	0.552
3	5	0.027	0.048	11	21	0.117	0.669
4	7	0.039	0.087	12	23	0.128	0.797
5	9	0.050	0.137	13	25	0.140	0.937
6	11	0.061	0.198	14	27	0.151	1.088
7	13	0.072	0.270	15	29	0.162	1.250
8	15	0.083	0.353	..	..	.....	.....

For the remaining half of the cam, the values are simply reversed, so that the cam follower recedes at a rate of speed corresponding to the speed with which it accelerates. It will be noted that any additional diagonal lines can readily be plotted by multiplying the required throw by the constant for the value of L and connecting this point with the vertex.

Chart for Determining Angle of Thrust

In Fig. 2 is given a chart for determining the angle of thrust of uniformly accelerated cams. It is advantageous to know previous to the actual laying out of a cam, just what the angle of thrust will be. For ordinary work, the cam should not have a thrust angle greater than 30 degrees, but for light duty, it can be as high as 45 degrees. The question most often arises in the form: What is the smallest cam that can be used for a given throw in an angular movement of a certain number of degrees?

The values of the smallest radius for a uniformly accelerated cam, for any throw with thrust angles of 30 degrees and 45 degrees, are plotted on the chart. The derivation of the formulas is as follows: Let

X = greatest throw in a single angular unit;
R = mean radius of cam;
N = number of angular units;
A = total angle of throw; and
S = total throw.

Then $\frac{A}{N}$ = a single angular unit, in degrees. Let L = length of arc in single unit; then

$$\frac{A}{N} : 360 = L : 2\pi R$$

Simplifying,

$$360L = \frac{2\pi RA}{N} \quad \text{or} \quad L = \frac{2\pi RA}{360N}$$

Now $\frac{X}{L}$ = tangent of greatest thrust angle. Hence

$$\frac{X}{L} = \tan 30 \text{ degrees and } \frac{X}{\frac{2\pi RA}{360N}} = 0.057735$$

Simplifying,

$$X = 0.010R \times \frac{A}{N}$$

Also

$$\frac{X}{L} = \tan 45 \text{ degrees} = 1$$

$$X = \frac{2\pi RA}{360N} = 0.0174R \times \frac{A}{N}$$

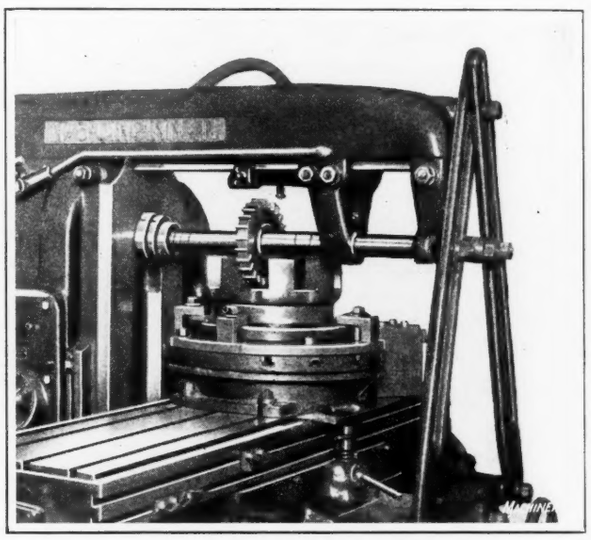
Now, for all ordinary cams the value of $\frac{A}{N}$ can be considered as never being larger than 5 degrees. Plotting the values of R when X equals any assumed value and $\frac{A}{N} = 1$, 1 1/2, 2, 2 1/2, 3, 3 1/2, 4, 4 1/2, and 5 degrees, we find a straight line for each set when $A = 30$ degrees and when $A = 45$ degrees.

To determine the value of R from the chart, obtain the value of X from the throw and the number of angular units as previously described, and at the intersection of this vertical line with the diagonal line for the number of degrees in a single unit, read the value of R in the vertical column at the left.

* * *

MILLING JAWS OF LARGE COUPLING

An interesting milling operation recently performed in one of the plants of a large electric company consisted of milling the jaws of a cast-steel flexible coupling. The set-up for this job is shown in the accompanying illustration. It will be noticed that because of the design of the casting the cuts were taken at a considerable height above the table, the work being mounted on an indexing fixture to permit convenient positioning for milling the different slots. The cutter was 10 inches in diameter and 1 3/4 inches wide.



Set-up used in milling Jaws in a Steel Casting

In rough-milling the jaws, a cut 5/8 inch deep was taken. A finishing cut was then taken which is said to have made the jaws accurate within 0.0015 inch. The job was done on a No. 5 Cincinnati plain milling machine.

* * *

"LONG-LIFE" MOLDS

The development of metal "long-life" or permanent molds for pouring molten metal of comparatively high melting temperature has been an important factor in lessening production costs. The usual method of casting in a foundry is to prepare a sand mold of the article to be cast, which is destroyed after it has once been used, thus requiring the making of a new mold for every new article cast. Continuous casting demands a method in which a mold can be used repeatedly. By the use of the metal mold more than 40,000 castings have been made from a single mold. Iron, unless of very high silicon content, if poured into a chilled mold, will be hard and white. A new process developed for casting iron in metal molds provides a heat barrier between the mold and the casting. The mold is thinly covered with a coating which checks the heat flow sufficiently to prevent the formation of chilled iron. This coating is further protected by a thick coating of lamp black, and the carbon, uniting with the skin of the casting, lowers its melting point, and thereby retards the cooling rate of the casting. Aluminum and brass have also been poured in these molds, and machinery and processes are said to have been evolved which are adaptable to non-ferrous as well as gray iron castings. The new process of molding is applicable to the largest as well as to the smallest type of casting.

Notes and Comment on Engineering Topics

The automobile industry, as might be expected, is the largest consumer of rubber and plate glass in the country. Seventy per cent of all the rubber manufactured in the United States is used for automobile tires, and 53 per cent of all the plate glass made is used in the automobile industry.

For the first time in the history of the electrical industry, the plans of the power generating companies include greater appropriations for transmission lines than for the extension of power generating capacity. Of the $580,000,000 scheduled to be spent by this industry in 1925, $315,000,000 is for transmission and distribution lines.

The manner in which new and epoch-making inventions become commonplace and everyday occurrences of business is indicated by the brief announcement of the American Telephone & Telegraph Co. to the effect that it now transmits photographs by wire as part of its regular commercial service between New York, Chicago, and San Francisco.

Two airplane engines have recently been developed, one of 500 and one of 800 horsepower, respectively, the smaller one weighing 730 pounds and the larger one 1072 pounds, or only 1.34 pounds per horsepower. The Liberty motor, of war fame, developed 400 horsepower and weighed approximately 840 pounds. Some automobile engines developing 25 horsepower weigh about 200 pounds. The achievement of an 800-horsepower airplane engine weighing only 1.34 pounds per horsepower is a distinct step in advance in the development of internal combustion engines.

At the present time there are fifty steamships and motor ships of over 1000 tons each, with a total tonnage of 309,270, under construction in the world for the carriage of oil in bulk. Of these "tankers" twenty of 101,510 tons are under construction in Great Britain and Ireland. The tonnage of vessels now being built in the world which are to be fitted with internal combustion engines amounts to 923,738, while the tonnage of steam vessels under construction is 1,530,884. The motor tonnage thus equals over 60 per cent of the steam tonnage, showing the remarkable development that is taking place in the adoption of this system of propulsion.

The difficulty of valves sticking when used in systems handling caustic solutions seems to have been solved by the use of "Genelite" as a facing for the rotating parts of the valves. Among the properties claimed for this material are those of not seizing and of being to a certain extent self-lubricating. "Genelite" is a synthetic bronze having uniformly distributed throughout its mass approximately 40 per cent by volume of very finely divided graphite. The material has the appearance of bronze and can be easily ground, but is not easily machined. It was developed in the research laboratory of the General Electric Co. as an improved bearing alloy.

It is estimated that the expenditures for highway development in the United States will remain at approximately $1,000,000,000 a year for the next ten or fifteen years. State Engineer Upham of North Carolina says that the savings due to improved highways are easily shown by the fact that the returns on the gasoline tax indicate that the average amount of gasoline used per car has been considerably less since the various state highways have been improved, and that as far as the community is concerned, this saving in gasoline alone more than pays for an improved highway system. In addition, there are savings of tires, savings in the upkeep of vehicles, and more than anything else, savings in time of transportation.

It is stated in "German Trade Reports and Opportunities," commenting upon the recent trip of the German rotor ship *Buckau* to Scotland, that a German marine association at a recent meeting discussed the economic side of this new type of vessel. It was stated that no saving in the number of the crew will result from the adoption of the Flettner rotor ship, and that any saving effected will simply be in the amount of fuel for the oil engine used in connection with the rotor ship. This saving, it is stated, will be offset by the higher insurance rates charged by marine insurance companies for rotor ships as compared with steamships. Commenting further upon the fact that the rotor can be used effectively at a moderate wind velocity only, the association mentioned took the view that the rotor ship cannot be employed to economic advantage.

Today, probably because of the fundamental law of division of labor, there is an increasing tendency to separate discovery and application. Thus we speak of the fields of pure science and of applied science as though they were unrelated. It should be remembered that knowledge, scientific or otherwise, is useless unless it can be applied to human problems of some kind. A learned man who does not use his knowledge to increase in some way the sum of human happiness is merely an object of curiosity. The field of work wherein scientific knowledge is applied to industrial problems has become known as the "field of engineering." The tendency to broaden this definition in recent years has been quite marked. Used originally to designate the design, construction, and operation of industrial works, it has been extended to cover practically everything in the way of industrial work, including the problems of humanity so far as they are affected by modern industrial methods.—*Dexter S. Kimball*

What is believed to be the largest refrigeration machine in the world was recently installed by the Carbondale Machine Co., in the plant of the Los Angeles Ice & Cold Storage Co. This machine has a refrigerating capacity equal to the melting of 700 tons of ice each twenty-four hours. It is driven by an 800-horsepower, 2200-volt, 3-phase, 50-cycle General Electric synchronous motor. The compressor is of the Carbondale Worthington feather valve two-stage type, with a low-pressure cylinder 26 inches in diameter by 30-inch stroke, and a high-pressure cylinder 16½ inches in diameter by 30-inch stroke. The machine operates at a speed of 150 revolutions per minute. The complete unit, in spite of its large capacity, occupies a floor space of only 400 square feet, and does the work previously done by four slow-speed compressors occupying a total floor space of 3200 square feet. The machine is carrying the cold storage and ice making load of the cold storage company's plant, and, in addition, is supplying refrigeration service through three miles of pipe line to over one hundred customers, including hotels, restaurants, and markets in the retail district of Los Angeles.

DRAFT ON PATTERNS

Draft is a tapering of all the vertical faces of a pattern to permit its removal from the sand without excessive rapping on the part of the molder. There is no rule fixing the amount of draft to give a pattern, but it is a good plan to allow as much draft as possible without distorting the pattern; this may vary from 1/32 to 3/16 inch or may even be as much as 1/4 inch per foot of height. The draft always extends away from the pattern face, or larger side of the pattern. Very small patterns and those of larger sizes to be used in molding machines are often made without draft.

TUNGSTEN

Tungsten possesses the remarkable quality of giving to steel, when alloyed with it, the characteristic of "red hardness," so that a cutting tool made from a tungsten alloy steel can be used at cutting speeds which heat the tool to a temperature at which carbon tool steels would lose their cutting qualities. Most of the tungsten produced is used as an alloying metal for steel. Tungsten is a very heavy metal, its specific gravity in the pure state being 18.8 (weight per cubic inch, 0.68 pound); in its commercial forms, the specific gravity ranges from 19.3 to 20.2, according to the treatment to which it has been subjected. Tungsten may be obtained in the market either in a compact form or in the form of a powder. Tungsten requires a higher temperature for melting than any other metal; it melts at about 3000 degrees C. (about 5400 degrees F.). The melting point is so high that it cannot be melted directly into a mass, but, when first obtained from tungsten-bearing ores, it is always in the form of a metallic powder. This powder may be worked into solid masses weighing up to two or three pounds. Tungsten does not oxidize readily, and is practically insoluble in the common acids. Its hardness varies from 4.5 to 8 on the Mohs hardness scale (on this scale, razor steel is rated from 5 to 5.5). It is sometimes harder than quartz, which has a hardness of 7, and may be almost as hard as topaz. Its specific heat is 0.034, and its electrical conductivity (silver = 100) is 14.

METRIC HORSEPOWER

The unit of power adopted for engineering work, as defined in the English system of measurement, is equal to 33,000 foot-pounds per minute, or 550 foot-pounds per second. The metric horsepower, used in countries where the metric system is employed, is equal to 75 kilogram-meters per second, which is only 32,550 foot-pounds per minute, or 542.5 foot-pounds per second. Hence, it is evident that the metric horsepower is about 1.5 per cent smaller than the horsepower employed in the countries using the English system of measurements.

FOOT-VALVE

A "foot-valve" is sometimes placed at the lower end of the suction pipe of a pump to prevent the suction pipe from emptying while the pump is at rest; consequently, when the pump is first started, it does not have to exhaust the air from the suction pipe, and prompt starting of the pump is secured, assuming that the foot-valve is tight enough to retain the water in the suction pipe. This valve is of especial value when the suction lift or vertical height of the pipe is considerable. When the pump is exposed to low temperatures during cold weather, it is advisable to have a drain fitted to the lower end of the suction pipe in order to empty the latter, in case the pump is to remain idle for some time and there is danger of freezing.

MOMENT OF A FORCE

The action of a force upon a lever causes a tendency on the part of the lever to turn about its fulcrum. The magnitude of this tendency depends, first, upon the magnitude of the force acting, and, second, upon the perpendicular distance from the line of action of the force to the fulcrum. If the force is increased, or its perpendicular distance from the fulcrum is made greater, the tendency to turn the lever about its fulcrum will increase. This rotating effect of a force about a fulcrum is termed the "moment of the force" and is equal to the product obtained by multiplying the force by the perpendicular distance from the fulcrum. If the force is measured in pounds and the distance in feet, the moment is measured in foot-pounds; if the force is measured in pounds and the distance in inches, the moment is measured in inch-pounds. The most common unit for measuring moments is foot-pounds. The most important principle to be observed with regard to moments is that the distance from the fulcrum to the force, generally called the "lever arm," must be measured on a line at right angles to the direction of the force.

NEON

Neon is a gaseous chemical element, the symbol of which is Ne, and the atomic weight, 20.2. Neon occurs in very small quantities in the earth's atmosphere, and was first discovered in 1898. It is a colorless gas having a specific gravity (compared with air as unity) of 0.674. It becomes liquid at a temperature of —243 degrees C. (—405 degrees F.), and solidifies at a temperature of —253 degrees C. (—423 degrees F.). Neon occurs in the air in greater proportions than any of the other rare gases, except argon. The presence in air is to the extent of from 1 to 2 volumes in 100,000 volumes of air.

SAND-BLASTING ABRASIVES

Sand is the most commonly used abrasive for sand-blasting on account of its relatively low price. Ordinary lake or river sand is inferior to sea sand and silica sand, as the two latter possess greater hardness and are therefore more lasting. River sand results in more or less dust, and it disintegrates rapidly. Abrasives such as steel grit and shot are used to a certain extent, and the use of these more expensive abrasives is warranted under certain conditions. For classes of work such as electroplating or galvanizing, the metallic dust adhering to the work would make its use prohibitive, because it prevents perfect galvanizing, although no difficulty is experienced in this respect with sand. There is no one abrasive that is best adapted to all classes of work. A selection must be made with due regard to reclaiming means, to greatest economy in operation, and to maximum production. All abrasives should be screened each time before using, to remove particles large enough to clog the nozzle, and also to eliminate fine particles which only produce dust and have no abrasive quality, but which consume some of the pressure. Screen separators, frequently operated by compressed air, may be used for this purpose.

STEAM-HAMMER RATING

The capacity of a steam hammer, or its nominal rating, is the weight of the ram and its attached parts, such as the piston and the rod. The steam pressure behind the piston is not considered, as far as the rating is concerned. For example, a 1000-pound hammer has reciprocating parts of that weight. The steam pressures for operating hammers usually vary from 75 to 100 pounds per square inch.

FLAT FILE

A flat file is parallel in both longitudinal sections, from the heel to the middle, and tapered in both sections from the middle to the point, the thickness of the point being about two-thirds and the width about one-half that of the stock from which the file is made. The flat file is one of the most common files in use and is not confined to any specific class of work, but is employed for a great variety of purposes. Ordinarily, the teeth are double-cut, and either bastard, second-cut, or smooth. A single-cut flat file is preferred for some classes of work.

UNIT SYSTEM OF MACHINE CONSTRUCTION

The principle of the "unit system" of construction is simply that of dividing a machine into groups of closely related mechanisms, and constructing them with independent frames or boxes in which the shafts, studs, clutches, gears, etc., are assembled. These units of mechanisms are assembled on the main frame to form the complete machine. The natural divisions of the engine lathe, for example, are the headstock, tailstock, carriage, apron, feed-box, change-gear box, etc. These mounted on the bed, require only the lead-screw, feed-rod, and legs to complete the lathe. This system, which has been applied extensively in machine tool design, has several marked advantages: It is the logical development of the interchangeable system of manufacture which has so greatly reduced the cost and improved the quality of manufactured products. The units are made independently in departments suited to the character of the work, by men who, specializing on each particular unit, become experts. The units, being interchangeable, can be replaced by the user in case of accident, with a minimum of trouble; they can be removed and returned to the factory for repairs at small expense for freight and handling. The units can be tested independently, and, if defects develop, they are corrected without seriously blocking the output of finished machines. If a complete machine is tested and found faulty, it is held until a minor defect, perhaps, is found and repaired. The same defect found in a separate unit would have been corrected before reaching the assembly floor and thus no delay at this stage would have occurred. An important advantage to the machine tool builder is the ease with which units can be incorporated in various designs. The builder, say, of milling machines, can use the same feed-box in several sizes and styles, and is thus able to produce a variety of designs at a minimum cost for jigs and fixtures, all in harmony with the general design.

NON-SPINNING ROPE

Non-spinning rope is a special type of wire rope made from eighteen strands of seven wires each. The object of so-called "non-spinning" hoisting rope is to prevent a free load suspended at the end of a single line of rope from rotating. The spinning of a rope endangers the life of workmen, and the constant attention required to guide the load is difficult and expensive. Non-spinning hoisting rope is constructed by first placing six strands of seven wires each (Lang's lay) around a hemp core. These six strands are then covered with an outer layer composed of twelve strands with seven wires to the strand laid in "regular" lay—that is, the wires in the strands are twisted to the left, but the strands themselves are twisted to the right or wound around the wire rope in the direction of a right-hand screw thread. Ropes of this type are made from various materials, according to the strength required for the service for which they are intended.

MITER GEARS

If the number of teeth in two bevel gears is alike, the gears are equal, the pitch-cone angle of each being 45 degrees, and the gears are commonly referred to as miter gears. All dimensions in the two gears are the same, and the gears are interchangeable.

HEAT LOSSES FROM BARE STEAM PIPES

The actual heat losses in a steam pipe depend upon the size of the pipe, its position, the nature of the pipe surface, and the velocity of the air surrounding the pipe. Horizontal steam pipes radiate heat more rapidly than vertical pipes, the reason for this being that the heated air surrounding a vertical pipe travels upward along the surface of the pipe, while with horizontal pipes the heated air rises immediately upon being heated, thus making room for cooler air, which is, in turn, heated. For all practical purposes, however, it is customary to assume a loss of 3 B.T.U. per square foot, per hour, for each degree F. difference in temperature between the steam in a bare steam pipe and the air surrounding the pipe, as previously mentioned. A good grade of asbestos or similar pipe covering will reduce this loss at least 85 per cent. Tests made on an 8-inch standard steam pipe 60 feet long, carrying steam at from 109 to 117 pounds per square inch gage pressure, and surrounded by air at temperatures varying from 58 to 81 degrees F., showed that each square foot of bare pipe surface radiates approximately 2.706 B.T.U. per hour, per degree average difference of temperature between the steam in the pipe and the outside air.

TURRET-SLIDES

Turret-slides for turret lathes may be divided into three general classes: The plain turret-slide, with a longitudinal feeding movement only and a turret that is revolved automatically by the backward movement of the slide; the set-over turret-slide, which has a cross motion that is utilized either for recessing or for radial facing with a single-point tool; and the universal turret-slide, which has longitudinal and cross movements similar to the set-over type, but which has, in addition, an intermediate plate between the cross-slide and the longitudinal slide that may be swiveled to allow the turning or boring of tapering surfaces. The cross-slide is below the swiveling member, so that parts may be faced off square with the spindle when the swiveling slide is set for taper work.

AIR FOR COMBUSTION OF FUELS

The theoretical amount of air required for the combustion of various fuels, in pounds per pound of fuel, based on typical analyses of each is as follows: Coke, 10.8; anthracite, 11.7; bituminous coal, 11.6; lignite, 8.9; wood, 6.0; and oil, 14.3. In practice, due to the impurities in fuel and the difficulty in getting air into contact with all particles, it is impossible to obtain perfect combustion with the theoretical amount of air, and an excess sometimes equal to double the theoretical amount is required. Usually, however, about 50 per cent excess air is sufficient to meet the requirements. This excess air is required because ideal conditions for combustion cannot be attained in actual practice, owing to the difficulty in supplying air to all parts of the fire uniformly. This results in some of the fuel receiving less oxygen than is necessary for complete combustion, while other parts have a surplus. On the other hand, if too much air is supplied and insufficient time is allowed after the gases have become incandescent, before they come in contact with the cooler plates of the boiler, combustion will also be retarded.

What Our Readers Think

on Subjects of General Interest in the Mechanical Field

KEEPING MACHINE TOOLS IN GOOD CONDITION

Anyone who reads the advertising pages of the popular magazines must have come to the conclusion that the art of keeping a youthful appearance has attracted the attention of the modern woman (and man) to a marked extent. There is no law against applying the same practice to machines. Most machine tools lose their youthful—we call it new—appearance far sooner than the people who run them; and yet, with reasonable care, this should hardly be necessary.

A foreman who permits inexperienced or careless men to abuse good machinery is incompetent. He has a better chance than anyone else to notice the abuse and to correct wrong practices. The needless hammering and checking of machined surfaces causes deterioration more quickly than ordinary wear. The deterioration is one that can be measured in dollars and cents too, and is apparent in the inventory lists of the shop.

Recently the writer had occasion to examine some "practically new" lathes that were offered for sale. Upon examination, it was found that the lathes were of modern construction and, as far as wear was concerned, were in good physical condition. The serial numbers on the lathes showed that they were not over three years old; but all the luster was gone from the paint, and most of the paint was gone above the bed. There was no machined surface, round or flat, that had not been marred and scratched. It looked as if the operators had spent a good part of their time in diligently tapping on the tailstock or the carriage with any sort of tool that was handy. The result was that the buyer concluded that his old lathes, which he intended to replace by these "practically new" machines, were about as good as the newer ones, although they were very much older in years. Hence he did not buy. DONALD A. HAMPSON

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SYSTEM IN READING AND FILING TECHNICAL LITERATURE

Contact with executives of manufacturing plants in various parts of the country has given the writer some helpful ideas pertaining to methods of reading and filing technical literature. From the president of one of the largest automobile manufacturing companies comes the following interesting statement: "We spend a considerable sum of money every year for books and magazines that we may keep abreast of the times. These magazines go to the various department heads throughout the organization, being passed on from one executive to another. The same system applies to books, although they do not go to more than two or three men at first, and recently the rule has been adopted that every book and magazine shall go first to the library and then be circulated from there, where a careful record may be kept.

"There is little use in providing technical matter unless there is some plan for preserving and making the valuable information it contains easily available. The library is located in our main office building, and is always open for the use of our employes in connection with their work. By having our workers make use of this technical literature, the quality of our product has been improved."

The plan in operation at this library is very simple. Every book and magazine comes direct from the in-bound mail desk and is at once catalogued. There is a routing card for each magazine, and as soon as it is catalogued, the magazine is carried on by the mail boy to the next department head. When a trip has been completed, the magazine is taken back to the library ready for those whose names are not on the reading list. Attached to each magazine that leaves the library is a card bearing the names of those who are to read it. These cards are retained by the mail boy until he has delivered the magazine to all the men named on the card.

Books are sent out to the shop only upon special request, and the mail boy is instructed to wait for books thus requested in order to make the deliveries more prompt. In this manner, the mail boy who visits each department at intervals of about an hour and a half can take a book or magazine to any department from which a request is received, thus eliminating the necessity of the worker going to the library. If some information is desired promptly, the telephone is employed or someone from the department goes directly to the library.

Each department head who reads a magazine may mark distinctly with a pencil the letter C upon the margin of any article which he deems of sufficient importance to be catalogued. Articles marked in this manner are catalogued in the card index by subject headings. The heads in many departments have their own individual notebooks in which they keep a record of the interesting material they come across in books or magazines. This is not necessary, however, as the system of marking and indexing makes it possible to locate quickly almost any article or information desired. RUSSELL J. WALDO

* * *

COMMENDATION AND CRITICISM

Some time ago one of your readers expressed himself through your columns in regard to the effect of commendation and criticism on employes. I believe that the points brought out by your correspondent are very good. It increases a man's confidence and self-respect to have those in charge commend him for his work, and it promotes a spirit of loyalty.

However, I also believe that there is another angle to the subject that is worth considering. Suppose Tom starts to work in a shop. From time to time he is congratulated on the successful performance of his work. What does he expect? The one natural thought in his mind is that if his employer appreciates his work, he will show his appreciation by giving him a raise in pay and greater opportunities for development. If you ask Tom what he thinks of the commendations, he will tell you that they are all right and that they make him feel like doing better the next time, if he can, but they won't buy bread and butter for his family. Appreciation expressed in material reward is, after all, the most sincere commendation. Unless the appreciation is expressed in that way, Tom may form an opinion of his own in regard to his ability, based upon the commendations, and conclude that the place for Tom is in some other shop.

After all, the real measure of a man's character is the manner in which he pays his bills—that is, his obligations—both literally and figuratively. If an employer recognizes the services of an employe as he would a bill, by giving equal and full value in return, the right kind of employe is at once stimulated to further effort in order that he may deserve another raise. His interest and that of the employer then become the same. He has no reason to doubt the sincerity of his employer, and he knows that commendations for good work are sincerely meant. A. T. G.

Feeding Devices for Automatic Machinery

By ALBERT A. DOWD

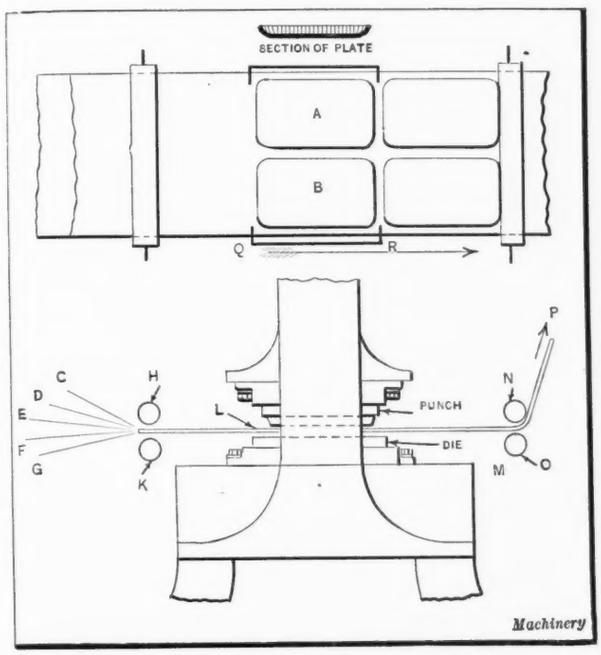


Fig. 1. Diagram illustrating Paper-feeding Problem

WHEN paper or cardboard is to be fed from a roll through a machine and cut off to length in the packing or wrapping processes, slight variations in length or width are not of great importance, but when fabricating forms from this kind of material by punching and forming operations, it is often necessary to provide some form of feed which is positive in its action and not likely to slip when starting or to overrun when stopping. The ordinary type of roll feed operated by ratchet and pawl can be applied in many cases, but it is not always satisfactory in its action. For example, in Fig. 1 a corrugated paper plate is to be punched from sheets by two dies arranged as shown at *A* and *B*. The work is to be done on a forming press of the ordinary type by means of suitable dies and feeding attachments. The general process with regard to the dies is to blank out the forms at *A* and *B*, carry them down into the dies, form, and eject them, but as this part of the work involves a simple punch and die, we need only consider it in its relation to the feeding mechanism.

It is the intention to draw the paper from five supply rolls, and carry it from these as at *C*, *D*, *E*, *F*, and *G* through rolls *H* and *K*. The problem is to pass the paper, five-ply, between the punches and dies at *L*, allowing the finished pieces to drop out of the scrap at *M*, while the waste paper continues on through rolls at *N* and *O* in the direction *P* to be taken care of in any convenient way. In order to economize in paper, the feed at each stroke of the press should be positive and move only the distance *QR*, as shown in the plan view. According to the diagram, this does not appear to be a serious problem, but when it is considered as a whole several troublesome matters are discovered.

Problems Encountered in Designing Feed-rolls

Fig. 2 illustrates diagrammatically some of the difficulties likely to be found. In the first place, the five paper rolls *A*, *B*, *C*, *D*, and *E* weigh several hundred pounds each, and if they are arranged as shown and the paper is drawn down or up, as the case may be, through feed-rolls at *F* and *G*, the starting of these heavy rolls would produce sudden stresses that would be likely to tear the paper. The take-away rolls at *H* and *K* would need to be of the slip or friction type, in order to take up the slack in the paper after punching and also to allow for a downward movement of the paper when punched at *L*. If we should attempt to use rolls *H* and *K* as feed-rolls and *F* and *G* as gathering rolls, the pull on the perforated and therefore weak section of the paper might cause breakage, as indicated at *M* in the diagram *N*. Ordinarily, two rolls arranged in this form would have only a line contact on the paper, and therefore would not give sufficient traction without more or less slip, which would mean that the feed would be uneven.

The common type of feed-rolls, as shown by the diagram at *O*, would not be satisfactory for several layers of paper as at *P*, *Q*, and *R*, although it would give good results for a single sheet. If the rolls *S*, *T*, and *U* were all the same diameter, there would obviously be differences in the surface speed of the three layers while passing between the rolls, and this might cause a "gather" or wrinkle which would give trouble.

On the other hand, if we pass the paper between two power-driven rolls *a* and *b*, as shown at *V*, and allow it to form a loop at *W*, carrying it forward through two other rolls *X* and *Y* by pulling at *Z*, it is evident that several things would be accomplished. A continuous power feed should be applied to the rolls *a* and *b* which would draw the paper steadily through and form the loop, as shown at *W*. Then, if the rolls *X* and *Y* are set up tightly to hold the various layers of paper together, it would be an easy matter

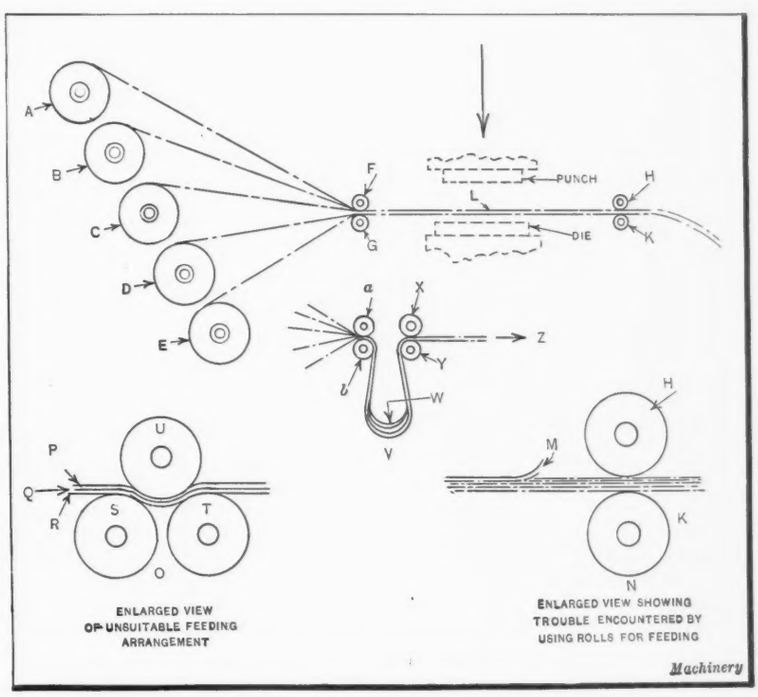


Fig. 2. Various Methods of arranging Rolls for feeding and taking away Paper from Supply Rolls

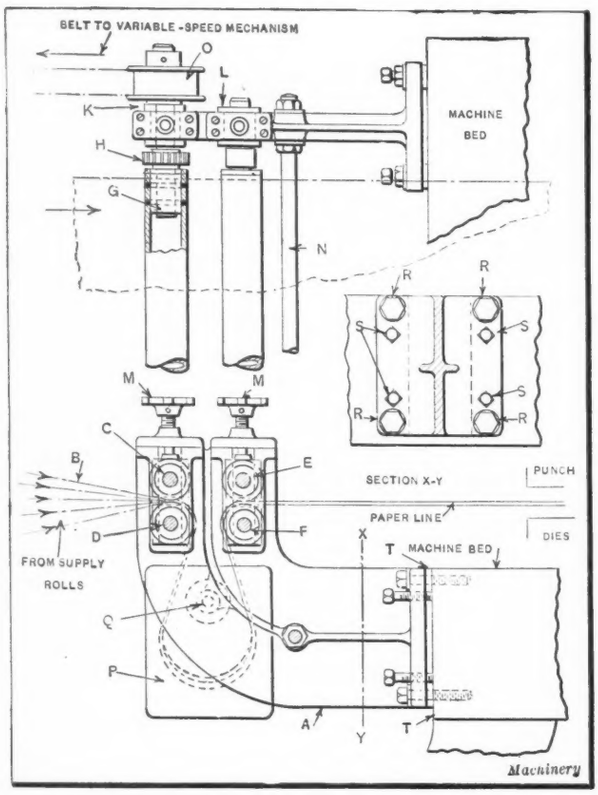


Fig. 3. Bracket and Feed-rolls employed at Source of Supply

to feed the paper in the direction *Z* by means of reciprocating feeding fingers that grasp the edges of the paper at each forward stroke. A method like this would avoid excessive strain on the paper, as the feeding fingers would only have to carry the weight of the paper in the loop and would not pull at all on the supply rolls.

Design of Feed-rolls

Fig. 3 shows details of the construction used in the bracket and feed-rolls. The roll-carrying brackets *A* are attached to the bed of the press, one on each side of the machine. The paper comes in, as indicated by the dotted lines at *B*, passes through the rolls, and forms the loop as indicated in the previous illustration. The rolls *C*, *D*, *E*, and *F* are made of brass tubing with steel plugs and a shaft pinned into each end, as shown in the section at *G*. The two rolls *C* and *D* are geared together, as shown at *H*, while the other rolls *E* and *F* run free. The supporting brackets are slotted to receive the square sliding pillow-blocks *K* and *L* that carry the roll bearings. These blocks are adjustable for pressure by the handwheels *M*. In order to stiffen the construction, a tie-rod *N* is passed from one bracket to the other. A standard type of variable-speed mechanism, the control of which is within easy reach of the operator, is driven from the press itself, and is belted with suitable reductions to the feed pulley *O*. The speed of the feed-rolls should normally be sufficient to form a loop that will be large enough to take care of the feed of the paper for each stroke of the press. In this particular case, the press speed was 20 strokes per minute and the paper is fed 9 1/2 inches per stroke. Hence the paper feed-rolls must revolve at a continuous speed sufficient to feed out at least 190 inches of paper per minute.

In feeding paper like this, the rolls should be made slightly larger at the end than at the center in order that the paper will be gripped by the edges more strongly than in the center. There is always a tendency for paper to run from one side to the other in feeding, and this form of roll helps to prevent this trouble. An additional preventive is provided in the guard plates *P*, which are of boiler plate and mounted adjustably at *Q* in the supporting bracket. It is easy to adjust these sidewise so that they bear against the edge of the paper in the loop and tend to counteract any tendency to run to one side or the other.

Design and Application of Brackets

In applying any special devices or attachments to a standard type of machine, brackets of various kinds must often be attached to different parts of the machine. Sometimes it is possible to attach these to finished surfaces, but more frequently they must be applied to a rough casting. The bracket is often made with several "chipping spots" which are dressed off by the workmen when fitting it to the machine, but at best this is a crude method. The arrangement shown in the section *X–Y* is very useful in cases like this. Four holes are drilled and tapped in the bed of the machine to receive the bolts *R*, these holes being located by measurement. The holes in the bracket have considerable clearance to allow for variations in setting. There are four set-screws at *S*, and so by manipulating these in connection with bolts *R*, it is comparatively easy to bring the bracket into the desired alignment. After this has been done the space *T* between the bracket and the machine bed can be filled with lead or babbitt, thus preserving the setting and giving a firm bearing to the bracket. There are many cases in which this idea can be applied to advantage.

Lay-out of Paper-feeding Mechanism

Fig. 5 shows a general lay-out of the machine with the paper-feeding mechanism applied, while Fig. 4 shows some

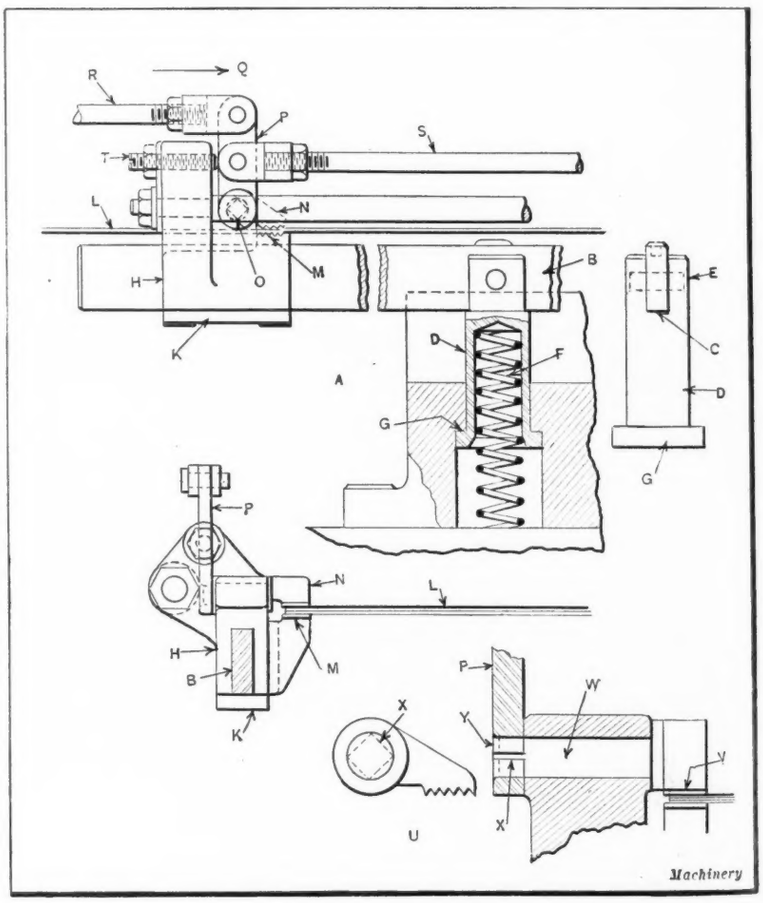


Fig. 4. Details of Paper-feeding Mechanism

of the details of the mechanism. The bracket previously described is shown at *A*, Fig. 5, and the paper (five-ply) runs through the machine as at *B*, being carried away by the take-away rolls at *C* and *D*. The die-holder *E* carries two spring plungers *F* and *G* on each side of the dies. These are slotted to receive the rectangular steel bar *H* which acts as a guide for the slides *K* and *L* on each side of the dies. These two slides are tied together longitudinally by a bar *M*.

The brackets *N* are attached to each side of the press and carry a block *O*, which can be moved up or down by means of the handwheel *P*. The cross-shaft between the brackets is a rocker shaft, to which are fastened brackets supporting rods *Q* and *R*. Rod *Q* connects with another at *S*, operated by the crank of the press, as indicated. All these rods are adjustably mounted, and those at *R* connect with the operating shaft *T*. As the crank revolves, movement is transmitted through the link *V* to the connecting-rod *W* and thence to another link at *X*. These two links are connected at *b*. This part of the mechanism is simple and does not need description.

The take-away rolls *C* and *D* are driven by a light friction device, which simply takes up the slack and keeps a continual light pull on the paper. These rolls are geared together and are adjustable in a bracket similar in form to the one previously described. Naturally the paper that has been perforated accumulates very rapidly and must be carried out of the way. By using overhead rollers high enough up to be out of the way, the scrap material can be easily disposed of.

Details of Feeding Mechanism

Referring to Fig. 4, the details of the paper-feeding mechanism can be easily understood. The view at *A* shows a partial view of one of the rear slides in position on the guide bar. A partial longitudinal section of the die-holder is also shown to illustrate the construction and arrangement of the spring plungers. The guide bar *B* passes through a slot *C*

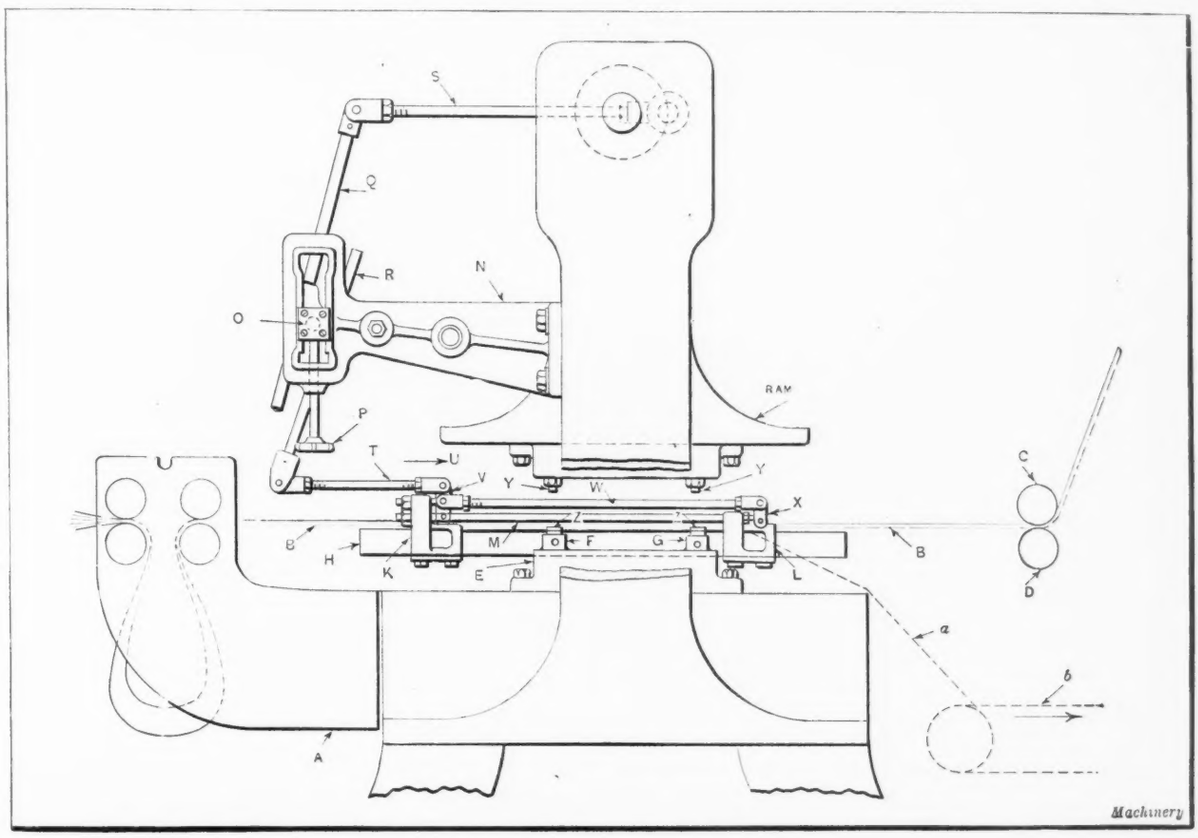


Fig. 5. Application of Paper-feeding Mechanism

to the end of short shafts, at the inner ends of which are gripping fingers that grasp the edges of the paper as soon as movement starts in the direction *U*, and as soon as the paper is gripped, it is pulled along until the end of the stroke. The slides *K* and *L*, being tied together, move in unison along bar *H*.

When the ram of the press descends and the punches come into action, the studs *Y* strike the ends of the hardened buttons *Z* set in bar *H*, and carry the whole sliding mechanism down. This arrangement allows the slide to operate independently of the movement of the ram, so far as interference goes, and the timing of the mechanism is such that the paper moves forward into position just before the ram descends, and moves backward while the punch and die are engaged, the gripping fingers releasing immediately when the backward movement starts. The work (not shown) is ejected in the usual manner by plungers in the bottom of the dies; it is carried upward to a position level with the face of the stripper plate, then carried forward by the forward movement of the perforated paper *B*, and dropped on the chute *a*, down which it slides to be carried away by the conveyor

in the top of the plunger *D*, and is pinned in position, as shown at *E*. The inside of the plunger is bored out to receive the stiff coil spring *F*. The upward movement of the plunger is limited by the shoulder *G*. Longitudinal slots are cut through the die-holder to receive the guide bar *B* when it is pushed down by the ram, as previously mentioned.

It must be remembered that there are four of the plungers —two on each side of the die-holder—all of which are depressed at the same time when the ram of the press descends. There are four slides *H*—all different—right-hand, left-hand, front, and rear. These slides are of cast iron and are a sliding fit on the guide bar, a cap *K* underneath serving to hold them in position. The paper *L* lies directly over a hardened steel serrated piece *M*, which is screwed to one side of the slide. Just above this is the steel gripping finger *N*, which is pivoted at *O* and connected to lever *P*. Normally, the finger is a trifle above the surface of the paper, but as soon as connecting-rod *R* moves in the direction *Q*, the paper is gripped firmly between *N* and *M* on this slide, and a similar action takes place on the other three

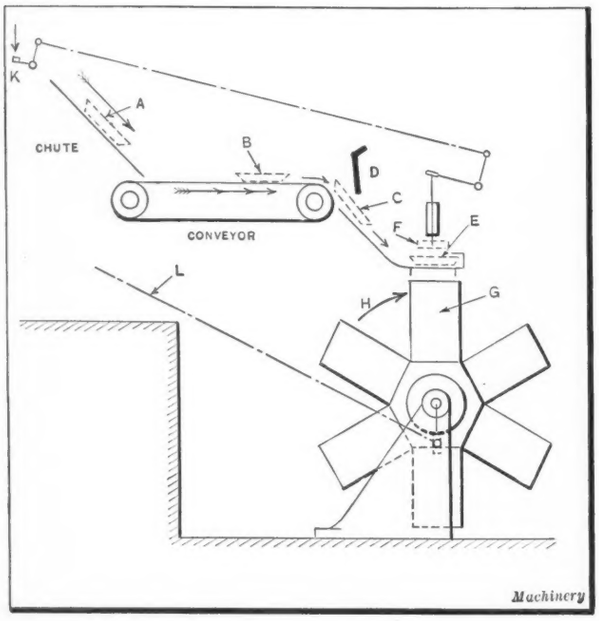


Fig. 6. Device used for nesting and packing Paper Plates

slides. Connection is made between the forward and rear slides by the rod *S*. A set-screw is provided at *T* to limit the movement of lever *P* on the return stroke.

The construction of the gripping fingers is shown in detail at *U*. They are made of a single piece of steel, with surface-hardened serrations at *V*. The shaft portion *W* extends across the slide, and is squared up on the end at *X*. The lever *P* has a square hole in it which fits the shaft, and after assembling, the end of the shaft, which has been left soft, is peened over at *Y* to hold it in place. Although this construction was somewhat expensive, it was considered advisable in order to prevent any possibility of lost motion developing, as might be the case if pins or keys were used. Care should be taken not to make the serrations in the gripping fingers so deep that they will break the surface of the paper and cause trouble in feeding. A good coarse knurl can be used here to advantage.

Conveying and Stacking Equipment

Fig. 6 illustrates the general method used in taking the pieces from the machine after they have been stamped, carrying them by a conveyor a short distance, and finally stacking them 250 at a time in a nesting device ready for the final packing. The pieces pass down an inclined plane when discharged from the press, as shown at *A*, and are carried rapidly by a conveyor, as shown at *B*, until they reach the end of it and drop off down another chute, as at *C*. A baffle plate at *D* prevents the pieces from getting out of position when leaving the conveyor. After they have passed down the chute as at *C*, they come to rest at point *E* directly under the plunger *F*. The plates are slightly flexible so that they lie (without falling through) on an opening slightly smaller than their largest dimension. When the plunger *F* descends, the plates are forced through the opening and into the nesting device *G* directly below. This also is slightly smaller than the outside dimensions of the plate, so that each lot of five pieces remains wedged at the point where plunger *F* has pushed it. As each succeeding group of pieces is forced into position by the plunger, those below it are crowded down little by little to the bottom of the nesting device.

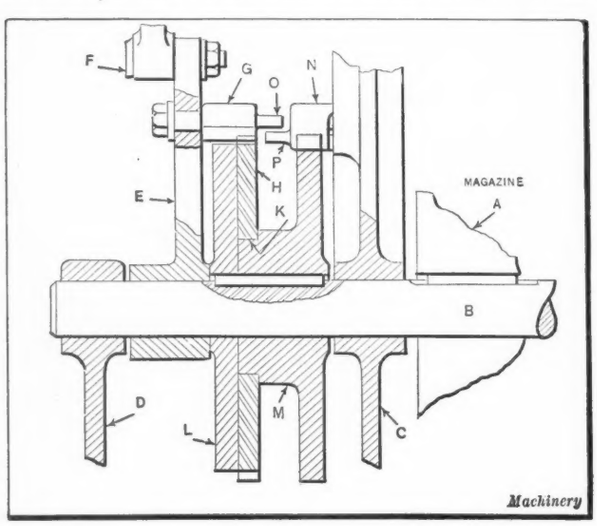


Fig. 7. Details of Indexing Mechanism

When fifty strokes have been made, the indexing device goes into action pulling the magazine around one station in the direction shown by the arrow at *H*. The operator can now open the part that has just been filled, and take out the pieces to pack them away in a carton. The operation of the plunger *F* is through ordinary bellcranks and connecting-rod by pressure of the ram as it strikes the point *K* each time it descends. The indexing mechanism is operated by a connecting-rod *L* attached to an eccentric controlled by the crankshaft of the press.

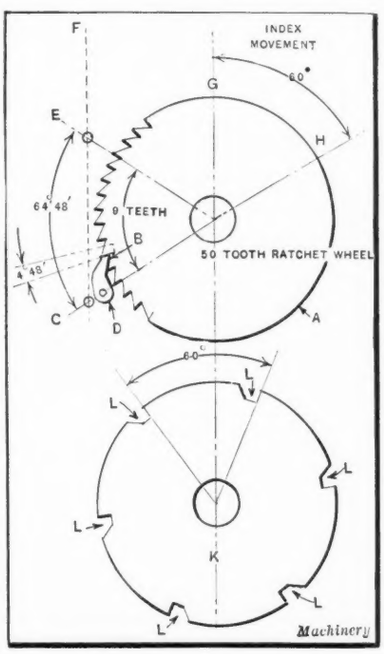


Fig. 8. Ratchets for Indexing Magazine

The requirements of the indexing device were that it should be positive in action, and that it should operate immediately after the fiftieth stroke of the press plunger, bringing an empty section of the magazine into position before the next stroke. The working out of the problem was as follows: At first, a ratchet gear with fifty teeth was considered, as shown at *A* in Fig. 8, and by calculation it was found that by using a ratchet and pawl designed to index nine teeth of the ratchet at each stroke of the press the ratchet pawl arm would be required to move from *C* to *E*. If one tooth *B* was cut deeper than the remainder, then only once in every fifty strokes would this tooth be in the position shown. Furthermore, the stroke of the pawl arm would be 64 degrees 48 minutes, which is 4 degrees 48 minutes more than required for the actual 60-degree indexing movement of the magazine. This extra movement was utilized for unlocking a dog which fixed the position of the device. By making another disk *K* and mounting it at the side of *A* and by using a pawl wide enough to reach across the faces of both disks, the pawl would drop into one of the notches *L* at every fiftieth stroke and carry disk *K* around exactly 60 degrees.

Reference to the sectional detail (Fig. 7) will give an idea of the construction. The magazine device indicated at *A* is keyed to the shaft *B*. A supporting bracket *C* on each side carries the magazine, plunger feed mechanism, etc. The end of shaft *B* has an outboard bearing in the bracket *D* to provide a rigid construction. The arm *E* is a running fit on shaft *B*, and is connected to the press by rod *F*. The pawl *G* is wide enough so that it covers both the ratchet wheel *H* and the indexing disk *L*. The ratchet wheel is a running fit on the hub *K*, but the disk *L* is secured to the member *M* which, in turn, is keyed to the shaft *B*.

Member M has six notches on the periphery, and it is locked at N by a suitable dog. A projecting lug on the dog at P is engaged every fiftieth stroke by another lug O on the operating pawl, thus pulling the dog out of the notch in the member M and allowing the whole mechanism to rotate 60 degrees, at which time the dog drops again. Except at the fiftieth stroke, the lug O rides over lug P, as indicated, but when pawl G drops into one of the notches in disk L, lug O moves down far enough to engage lug P and thus pull out the dog.

A principle similar to this can often be applied to an indexing mechanism, but as in figuring out such a device on paper there are always chances for errors, it is best to make a simple pasteboard model, full size if possible. This particular job was demonstrated by laying out a ratchet gear with fifty teeth, and cutting it out of pasteboard and pinning it to the drafting table at the center. Then by moving it nine teeth at a time, it was proven to be correct in principle, before going ahead with the actual design.

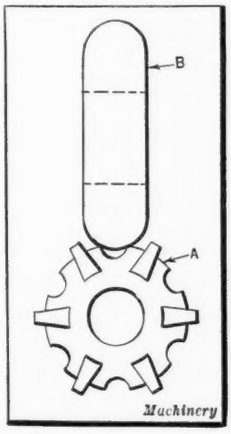
* * *

METHOD OF SECURING INSERTED REAMER BLADES

By ANDREW WEBSTER

Reamer blades of the inserted type which are held in position by frictional contact frequently become loose as a result of the constant torsional stresses to which they are subjected. Calking or peening the body metal against the resistance side of the blades is the method most commonly used to remedy such trouble. This procedure, however, reduces the area of contact between the blades and the holder, and obviously a reamer repaired in this manner will stand up only a short time. Such methods also produce unsightly dents or bruises on the body of the tool.

As a result of successful experiments, the writer developed a method of rolling which gives uniform rigidity to the inserted blades. Referring to the illustration, the reamer A is mounted on the centers of a plain milling machine, and the roller B is held on the machine arbor with its axis at right angles to the axis of the reamer. The sides of the roller are supported, but the pressure is not sufficient to prevent it from turning freely when brought into contact with the reamer body, and the table is traversed back and forth under the roller. No power is required for performing the rolling operation, the table simply being fed back and forth by hand.



Securing Inserted Reamer Blades by rolling

The radius of the spherical periphery of the roller is made somewhat larger than that of the chip clearance groove in the reamer body. The rolling pressure on the top corners of the grooves causes the metal of the body to press against the sides of the blade and thus form solid resistance walls.

* * *

According to a recent statement by the Bureau of Public Roads of the United States, $80,000,000 was collected by various state authorities in 1924 through the medium of the gasoline tax. Thirty-five of the forty-eight states and the District of Columbia now impose such a tax, ranging from one to three cents a gallon in all states except Arkansas, which levied a four-cent tax. Although thirty-five states impose a gasoline tax, only about one-half of the motor vehicles operated, or approximately 7,500,000, are affected, since several of the states that do not impose the tax have the largest registration. On the automobiles and trucks affected, the average gasoline tax per car in 1924 amounted to $10.30.

LAYING OUT ANGLES WITHOUT PROTRACTOR OR TABLES

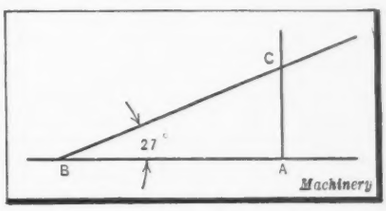
By HERBERT A. FREEMAN

The accurate determination of angles with a protractor is difficult because of the small radius at which the readings are taken. More exacting requirements in laying out angles are met by using tables of natural tangents to find the length of the side of a right-angle triangle which lies opposite the angle to be laid out. A third method of performing this work, described in this article, involves the use of a formula. The latter method does not require interpolations, and is entirely independent of tables of any kind. The formula is easily remembered and is written

$$\text{Tan } x = x + \frac{x^3}{3} + \frac{2x^5}{15}$$

in which x is the angle desired, measured in radians. Radians differ from degrees in that they are a much larger unit. Thus, 180 degrees is equal to approximately 3.1416 radians, or 1 degree equals $\frac{3.1416}{180} = 0.01745$ radian.

Referring to the illustration, let us assume that we are required to lay off at B an angle of 27 degrees. To facilitate the calculation of tangent x, write the formula in the following form:



Angle laid out by Use of Formula

$$\text{Tan } x = x + \frac{x^3}{3} + 0.4x^2\,\frac{x^3}{3}$$

If 1 degree equals 0.01745 radian, 27 degrees equals 27 times 0.01745 or 0.471 radian. Now by substitution in the foregoing formula we have,

Tan 27 degrees = 0.471 + 0.0348 + 0.0031 = 0.5089

We now lay off line AB equal to 10 inches, and at the point A erect the perpendicular AC, the length of which is 10 times tangent x, or $10 \times 0.5089 = 5.089$. A line through points B and C forms the required angle CBA.

Angles involving minutes and seconds can be laid out readily, by first expressing the required angle in decimals of a degree, and reducing the result thus obtained to radians. If we compare the result 0.5089 with the value given in the tables of trigonometrical functions, which we find is 0.50953, it is obvious that the error by the arithmetical method is less than one part in a thousand.

If the required angle is greater than 45 degrees, the complement or supplement should be calculated, keeping the angle calculated always no larger than 45 degrees.

The formula employed in the method described represents a little study in higher mathematics (differential calculus) with the mystery extracted, being the first three terms of $f(x)$ equals tangent x expanded by Maclauren's Theorem in the region of rapid convergence. If this had been mentioned at the beginning of the article, many readers who have a limited knowledge of higher mathematics would perhaps have read no further.

* * *

The tonnage of ocean-going vessels now building in the world which are to be fitted with internal combustion engines amounts to nearly 1,000,000, while the tonnage of steam vessels under construction is slightly over 1,500,000. The internal combustion engine tonnage, therefore, is approximately 40 per cent of the total ocean-going tonnage being constructed. In Denmark, Germany, Holland, and Sweden the internal combustion engine tonnage under construction greatly exceeds the steam tonnage. Eighty-seven ships of between 5000 and 10,000 tons, seven between 10,000 and 15,000 tons, and six between 15,000 and 22,000 tons with internal combustion engines are now under construction.

Current Editorial Comment

in the Machine-building and Kindred Industries

THE DISTRICT APPRENTICE SYSTEM

A new idea in connection with apprenticeship training is being developed. The difficulty of adequately training apprentices in small shops, or in those making a single product on which only a few operations are performed, is generally recognized. But both the small shop and the specialty shop need skilled machinists, and what appears to be a successful attempt to provide them has been made in Milwaukee by the inauguration of the "district apprentice system." A group of shops in a given locality, or in a certain district of a large city, cooperate in the training of apprentices, who are transferred from shop to shop to provide them with diversified training. The specialty shop may take them for only a few weeks, teaching those processes that are highly developed in its plant; the small shop takes them in hand for training in the processes likely to be more highly developed in a small organization than in a larger one. In this way all the shops in a certain locality aid in developing an all-around mechanic, each one bearing its share of the burden of providing for the supply of future skilled machinists, and none can offer the excuse that the special conditions under which it operates make it impossible to carry its share of this obligation. At the same time, the apprentice profits by obtaining a more all-around training than he would be likely to get in a single shop. His experience becomes broader and his knowledge of shop conditions in general more complete; hence he will be a better mechanic.

The industrial leaders responsible for the development of this system in Milwaukee are highly enthusiastic about it, and it is likely that the method will be successfully introduced in other industrial centers as soon as those interested in industrial training learn about it. Considerable attention was given to the subject at the recent convention of the American Society of Mechanical Engineers in Milwaukee, and a message will be carried to the East by papers to be read by Milwaukee members at the section meeting of the society to be held in New Haven, Conn., in September, in conjunction with the annual machine tool exhibition in that city.

* * *

WHAT WILL THIS MACHINE DO?

Much of the publicity matter sent out by manufacturers of machine-building equipment is confined largely to descriptions of various important constructional features of their machines, the primary object being to show that the equipment itself is superior to others in design and workmanship. Although prospective purchasers undoubtedly are interested in these features, many inquiries which we receive indicate that their first consideration is the adaptability of the equipment to their work. Questions about design and workmanship may arise later, but, primarily, prospective buyers want to know what a machine is capable of doing, and particularly in what respect it is more efficient than the older designs which they now have.

Many machine tool builders, recognizing the importance of this point, include in their publicity matter various typical examples of work, showing both production possibilities and range of application, and others might adopt this policy to advantage. The idea of featuring production, either as regards kind, rate, or quality, is particularly important for the newer and more special types of equipment which prospective users do not know about.

The equipment manufacturer's catalogue or pamphlet is often his only representative with some firm which is considering the installation of new equipment. Such literature is, in effect, the manufacturer's advance agent, and the sale in question may depend upon the kind of information it contains. Descriptive literature which shows at a glance a machine's productive possibilities, or the various classes of work which a given tool or appliance may be capable of, is sure to be a more effective adjunct to the sales organization than matter which merely features points pertaining to design or construction.

* * *

A SHOP WITHOUT RED TAPE

In the shop of a manufacturer who makes a nationally known product in the machine shop field, we were impressed with the absence of "non-producers." There was no elaborate cost-keeping department and only a small number of clerks, the conduct of the business being concentrated in the hands of only three executives. It seemed almost impossible that a shop could "run itself" to the extent that this shop evidently did.

The secret, we found, lay in the policy of carefully selecting trustworthy employes, keeping them, and depending almost entirely upon the individual responsibility of each foreman and of the workers themselves. The men know what they are expected to do and are left to themselves largely. The result of carefully selecting steady and trustworthy men showed itself in the unusually small labor turnover in the shop. In two years, out of each 100 men employed 93 still are with the concern.

It would appear that lack of complete time- and cost-keeping systems in this plant would make it difficult to maintain production; but the output is exceptionally high, and has been increased about 50 per cent in the last two years, without increasing the force. Improved manufacturing facilities have, of course, been added. The pride of the individual workman in his ability has been preserved, and the considerable number of non-producers so often used for keeping records that in themselves have no commercial value, is eliminated. By cultivating the human side of the working force, it has been found possible to dispense with most of the systems and red tape that eat into profits; and a more loyal, close-knit organization has also been created.

* * *

SALESMEN OR ORDER TAKERS

Said a busy executive, "I divide into two classes the men who help to keep this shop running by getting names signed on the dotted line—salesmen and order takers. I wish we had more of the former and none of the latter."

Then he referred to a salesman who found his regular customers well stocked with the general type of tools that he was selling; but it so happened that his firm had brought out a new cutter with unusual capacity for removing metal. Instead of waiting to be told that "no cutters are needed today, as we have plenty of the regular stock on hand," he immediately brought out his new cutter, got permission to demonstrate it on a machine in the shop, set it up himself and invited all the shop executives to see it in operation. He nearly always came away with a good order, although there was usually a stock of old cutters on the shelves.

The successful salesman possesses initiative and originality. He renders real service to his customers, gives information, educates them when he can and thereby helps them to make profits; he is a *getter* of orders rather than simply a *taker*.

Telling the World of Your Wares

Publicity Methods Used in Marketing Machine Tools

By H. S. RIGGS, The Lodge & Shipley Machine Tool Co., Cincinnati, Ohio

THE mere design and manufacture of a new machine and the preparation of descriptive literature will not place orders on the books; an effective method of getting the sales literature into the hands of prospective customers is an indispensable step in the process. "Telling the world" is indeed a vital link in the entire manufacturing and sales chain, and to do it right means first, to plan the work carefully and then to carry out the plan with precision. To obtain the maximum amount of effective publicity for a new machine, requires a great amount of thought and care, and no phase of the campaign must be overlooked.

The Function of Trade Paper Advertising

The trade paper offers the manufacturer a most effective medium for introducing his new product, but it must not be depended upon as the sole means of publicity in an introductory campaign. Trade journal advertising should be supplemented by other sales methods. Many machinery manufacturers have the mistaken idea that the trade paper can be their only salesman and all that is needed is to insert an advertisement—sometimes in a single issue—and forthwith, in roll the orders. However, the experienced manufacturer knows that this cannot be done and that the results from advertising depend upon the constant placing of the advertiser's name and his product before the buying mechanical public. Hence, supplementary sales methods should be employed.

The company with which the writer is connected employs methods of publicity that have produced very favorable results. The success is not attributed to the liberal use of any one method of publicity, but to the concerted efforts expended upon all the different methods. The manufacturers who have become leaders, not only in the machine tool field, but in every field, are those who, having a first-class product to sell, have made use of all the avenues of publicity and salesmanship available to them. Therefore, in addition to trade journal advertising, booklets giving a comprehensive description of the machine and its uses are carefully prepared, and are planned and carried through simultaneously with the trade paper advertisements. The three principal avenues for publicity will now be described in detail—the booklet, the trade paper advertisement, and legitimate news publicity through the editorial columns in trade journals.

The Preparation and Distribution of Descriptive Booklet

During late years it has been the policy of the company referred to, to put the whole story relating to a machine in a booklet. In other words, a man looking through such a booklet will find all the information relating to a certain type of lathe, for example, in one place. The idea is to give him all the facts possible. The booklet starts with a few words about the history of the company and the reason why it is qualified to furnish the product described; then follows a thorough description of the machine and its construction, with ample illustrations; lastly, concrete examples of work done on the machine are given, showing line drawings of the work and photographs of the tool set-ups, together with complete information about each job. To this information is added complete specifications of the machine. With such a booklet in his hands, the prospective buyer can obtain all the information he wants, and when he turns over the last page, he knows definitely whether such a machine would be adapted for use in his shop.

Particular care is taken to see that an attractive cover is provided for the booklet. To hold the reader's interest, it is well printed and arranged with special care, the layout on each page being designed with this in view. A booklet will not pay for itself unless it is read. If it is attractive, the chances are greatly in its favor.

After the booklet has been made up and it is definitely known when it will be ready for distribution, a release date for all publicity is decided upon. The idea of a release date is to concentrate the effect of all the different types of publicity used. The booklet will be in the mails, and the trade paper advertisements and editorial descriptions of the new machine will be published at approximately the same time. When the prospective buyer's attention is called to a new machine through a number of different channels at the same time, the value of the publicity is greatly enhanced.

Cooperating with Dealers, Agents, and Representatives

A general letter is next written to all dealers, agents, or representatives, stating that a new type of machine is soon to be introduced. A description of the machine is sent to them, and they are requested to send in the names and addresses of firms, together with the names of the interested officials, who may have use for such a machine. These names are constantly checked by personal calls of the dealer's salesmen, and can be relied upon to be active. In the meantime, a live sales letter is written. This letter is multigraphed, and the names and addresses of the men sent in by the dealers are typewritten to match the multigraphed letter. The letters are then signed individually.

It is better for the manufacturer to send out these letters himself than to have the dealers do it, because a letter from the manufacturer carries with it a certain prestige, the value of which should not be underestimated. The letter is dated a few days ahead of the release date, and is placed in duplex envelopes, in which the booklet is also put. The advantage of using duplex envelopes is that it enables the prospective customer to receive the letter and the booklet at the same time, so that the interest aroused by the letter will not lag before the booklet is received.

The letters and booklets in the envelopes are then made ready and mailed so as to reach the prospects a day or so ahead of the date when the trade paper advertisements and the editorial descriptions of the new machine are released. When the prospective customer already has the booklet in his possession, it saves him from writing for a copy when he sees the advertisement.

The Planning of Trade Paper Advertising

While the work described in the foregoing has been done, the trade paper advertising has been carefully planned. It is the practice of the firm with which the writer is connected to use double page spreads, as this makes it possible to use ample illustrations and say what is to be said in readable type.

The advertisement is provided with a heading that will attract the eye. To increase the interest, a photograph of a tool set-up, together with a line drawing of the job, is used. Facts concerning this particular set-up are given, as well as facts about the machine itself. A photograph of the complete machine is also used, and the advertisement is concluded with a reference to the booklet that describes the machine and its use in greater detail.

It is of considerable advantage to show a picture of the booklet offered, because this increases the reader's interest, and he is more likely to take advantage of the offer to send for a copy. It is advisable to tell the reader that in sending for the booklet he assumes no obligation. It might be assumed that he would know that this is the case, but the simple assurance in the advertisement to this effect overcomes any hesitancy on his part.

Usually a series of such advertisements is run pertaining to a new machine when it is being introduced. The length of the series depends largely upon the type of the machine. Sometimes six consecutive weekly issues and two monthly issues are used. Not long ago, however, a very successful trade paper campaign extended over a period of four months, featuring a single machine. The first of the series of advertisements would appear on the release date originally set.

As the mechanical world is always interested in something new, publishers of trade journals have made it a practice to illustrate new machines and devices brought out in their field as news items when the first announcement of the new machine is made. Hence, when a new machine is put on the market, a carefully prepared description of it, calling attention to its general characteristics and new features of design, together with photographs of the machine, examples of work, and tooling set-ups, is sent to the editors of the different trade journals with the request that they do not publish the description previous to a certain date.

Following Up the Results of the Advertising

After the advertisements have appeared, inquiries and requests for booklets begin to come in. A copy of the booklet is mailed in a duplex envelope, together with a letter advising that further information about the machine will gladly be given and that representatives are located in all territories, who can promptly give this additional information. A carbon copy of this letter is sent to the dealer or agent in the territory where the inquiry originated, with instructions that he get in touch with the inquirer. The dealer always writes and often calls on the prospective customer, immediately opening the avenue to future business.

If more than ten days pass from the time when the agent has been notified, without any report being received relative to the prospects for a sale, a letter is written asking him for a report. This follow-up is renewed at intervals until it is definitely determined from the agent that the inquiry will either result in an order or that it is "dead."

Large and well-known machine tool builders are represented practically all over the world. If, however, an inquiry originates in some territory where there is no representation, the whole matter is handled direct by mail, and a series of follow-up letters is sent until a definite conclusion has been reached.

A campaign such as outlined can be applied not only to new machines, but also to machines that have been on the market for a number of years. Some time ago such a campaign was conducted with reference to a manufacturing lathe. This lathe was not a new design, as it had been on the market for several years. However, a new booklet was prepared with numerous examples of work, together with line drawings and complete information about each job. These examples, together with a thorough description of the lathe and its possibilities, made a very attractive booklet. The booklet was advertised along the lines just mentioned, with the result that the sale of this particular lathe showed a marked increase for nearly a year afterward.

Conclusion: Careful Planning Brings the Best Results

To introduce a new machine successfully or to increase the sales of one already on the market, a thorough and careful planning of the publicity is necessary. Everything in connection with the whole publicity campaign should be thoroughly thought out beforehand. The idea that trade paper advertising alone will do the trick, and especially that a few advertisements not consistently followed up will be of any avail, should not be entertained. A manufacturer who believes that this can be done might as well expect a gear with one tooth to transmit power. The trade journals do not claim to be the only selling means at the manufacturer's disposal. They are merely the first important link in a whole chain of publicity. The success is not due alone to trade paper advertising, it is not due alone to editorial descriptions, it is not due alone to any direct-by-mail campaign—it is the *concerted power of all these* that puts orders on the books.

The importance of each phase or link of advertising, therefore, cannot be too thoroughly emphasized. Each does its part to introduce the product to the prospective buyer and convince him of its value to him. It may be difficult for the small advertiser to realize this, and he may think that methods such as outlined in this article apply only to some businesses and not to others, but they are equally applicable to all fields. Concerted, carefully planned advertising through trade papers, booklets, and sales letters holds good, whether $1000 or $50,000 a year is spent for publicity.

* * *

FORGET YOU WENT TO COLLEGE

In a bulletin issued by the National Industrial Conference Board under the striking title "Forget You Went to College," the results of an inquiry into the weak points shown by graduates of engineering schools in their early years of practical experience in industry are summarized. The importance of practical experience for the college man is emphasized. Without practical experience, it is stated, he will have little opportunity to put his theoretical training to real use. He must serve a certain apprenticeship period in the shop, and during that time he must rub shoulders with the ordinary workman.

"It is during this time," continues the bulletin, "that he has an opportunity to learn things about the industry that he will never have again, provided he is willing to work in the shop the same number of hours as the workman, to get his hands dirty, and to do the many menial little tasks he must learn to do in order to comprehend the practical nature of the bigger problems in industry. The all-important thing is that he know how to get along with men. He must gain their confidence and their good will, or he will learn little about the work. It would be fatal for him to be considered 'stuck up' by the workmen. If he approaches them, however, in a spirit of frank humility, showing a willingness to learn from them what he did not learn at college, he will find out things about the industry, the workmen, labor problems, and the 'tricks of the trade' that even the president of the company does not know."

Among the complaints of the shortcomings of college graduates during their early years in industry, employers who answered the questionnaire sent out by the National Industrial Conference Board emphasized particularly their impatience relative to quick promotion, their over-rating of the college course recently completed, and their under-rating of the importance of the details of practice, their unwillingness to work long hours in the plant and to undertake actual shop work, their lack of understanding of business principles and of the practical aspects of industry, and their inability to handle themselves in such a way in their contact with the workmen in the shop as to gain the friendship and command the respect of the men.

* * *

At a recent meeting of the Engineering Society of Buffalo, the following officers were elected: President, Major George H. Norton, chief engineer, Grade Crossing Commission; vice-president, George Brigham, district representative for the Portland Cement Association; secretary, Roswell Farnham, district sales engineer, Buffalo Forge Co.; treasurer, Bert A. Hansen, manager, Buffalo district, Cutler Hammer Co.; and executive secretary, John R. Owen. The headquarters of the society are at the Hotel Statler.

Optical Measuring Tools

Microscopes of Measuring and Binocular Types; Optical Flats; Optical Thread Tool Gage; Optimeter for Precision Measurements—Concluding Article

IN the first installment of this article, which appeared in June MACHINERY, several optical measuring tools or instruments for use in shops, tool-rooms, and inspection departments were described, including a toolmaker's microscope, an optical gear tooth caliper, an optical thread caliper, an optical twist drill gage, and an optical bevel protractor. The present installment, which concludes the article, will deal with a measuring microscope, a binocular microscope for fine inspection work, the use of optical flats, an optical thread tool gage for setting thread-cutting tools in the lathe, and finally, with the "optimeter" which is used for extremely accurate measurements in checking standard gages or work requiring great precision. All these tools or instruments were made at the optical works of Carl Zeiss, Jena, Germany, and have been placed on the market in this country by George Scherr, 142 Liberty St., New York City.

Measuring Microscope—Binocular Microscope

A microscope arranged expressly for taking linear measurements in one direction is shown in Fig. 12. This instrument gives readings directly in millimeters and hundredths of a millimeter, and is especially adapted for measuring the diameters of ball impressions in connection with the Brinell hardness test, although it may, of course, be utilized for various other measuring operations. The microscope is supported by a slide which is moved laterally by a micrometer screw. The main scale of the instrument, which is on the cross-slide at *A*, is graduated from 0 to 50 millimeters, and the large dial *B* of the micrometer screw has 0.01 millimeter graduations. As the latter are widely spaced on the large dial, subdivisions may readily be estimated.

In the field of observation, there is a spider-line cross which is used in taking measurements by setting it with reference to points or edges on the work in the usual manner. The standard magnifying power of the microscope is twenty-one times, but sets of interchangeable objectives and eye-pieces are supplied, so that the magnification may readily be varied to suit different classes of work. The extreme range of measurement with the particular size illustrated is 50 millimeters horizontally and 75 millimeters vertically, the latter dimension representing the maximum distance from the table to the objective. A camera attachment for taking photomicrographs is also made for this instrument.

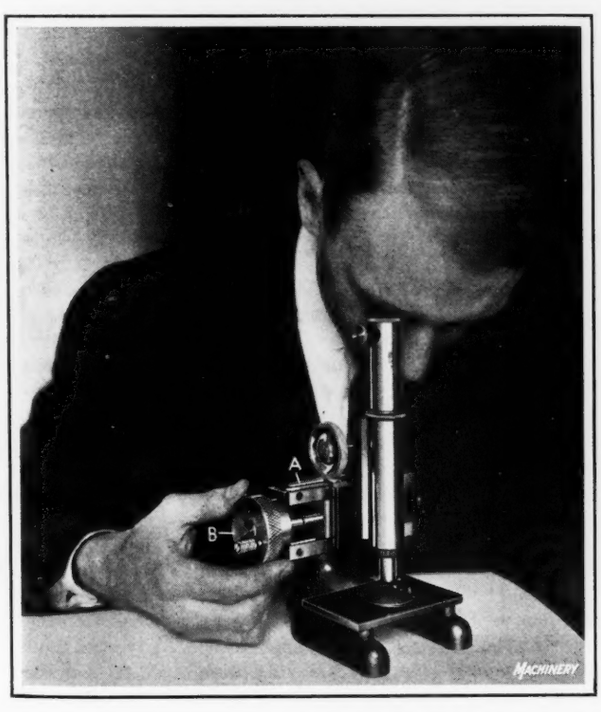


Fig. 12. Measuring Microscope used for checking Linear Measurements

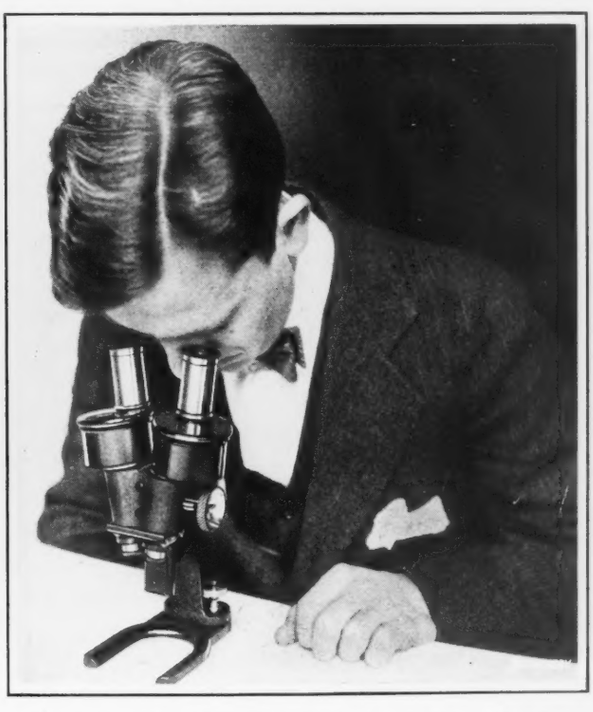


Fig. 13. Binocular Microscope for inspecting Small Precision Work

Fig. 14. Testing Micrometer by Means of Optical Flat

The binocular style of microscope (see Fig. 13) is intended for all kinds of fine inspection work, such as examining small parts, the grain of fractured metal, etc. The binocular feature enables the observer to obtain a stereoscopic view of the part being inspected. In other words, objects appear in their true relief or perspective, which is a decided advantage when inspecting small instrument parts, etc., in order to detect slight imperfections which would not be apparent to the naked eye. The vertical adjustment of this microscope and of the one shown in Fig. 12 for obtaining the proper focus, is controlled by a knurled thumb-screw and a rack and pinion.

Optical Flats

A simple and rapid method of checking plane surfaces when great accuracy is required, is the use of "optical flats." These flats are made of a special brand of glass, and the surfaces are the nearest possible approach to perfect planes. Optical flats are intended only for testing surfaces that have been made very accurate by careful lapping.

In testing such surfaces, all dirt or dust is first removed from both the glass and the work; then the optical flat is wrung on the work sidewise, with a slight pressure. If the lapped surface is sufficiently accurate, rainbow colored bands caused by the interference of light waves become visible across the working face of the optical flat. Ordinarily, lapped surfaces are passed as satisfactory if these interference bands are visible, but for exceptionally accurate work, the nature or formation of the bands is considered. Thus if a surface is perfectly flat, the bands extend across it in straight parallel rows, whereas the slightest amount of concavity or convexity would cause more or less curvature or irregularity of the bands.

The Zeiss optical flats which are intended for the general testing of plane surfaces, are 1 3/4 inches in diameter. One grade is guaranteed to be accurate within limits of 0.000004 inch and another grade to 0.000008 inch. Smaller flats having a diameter of 1 3/16 inches are made in sets of four, and are intended especially for checking micrometers. Three flats of this kind may be seen in Fig. 14. They serve to check not only the flatness of anvil and spindle faces, but the micrometer readings as well. The thickness of each flat is engraved on the edge, and is given to five decimal places. The four flats in the set increase progressively in thickness slightly over 0.006 inch, so that the micrometer readings may be checked at four different points equivalent to quarter turns of the graduated sleeve. By this simple method a micrometer may be tested, either to detect errors resulting from wear, or as a means of checking the readings after the adjustment.

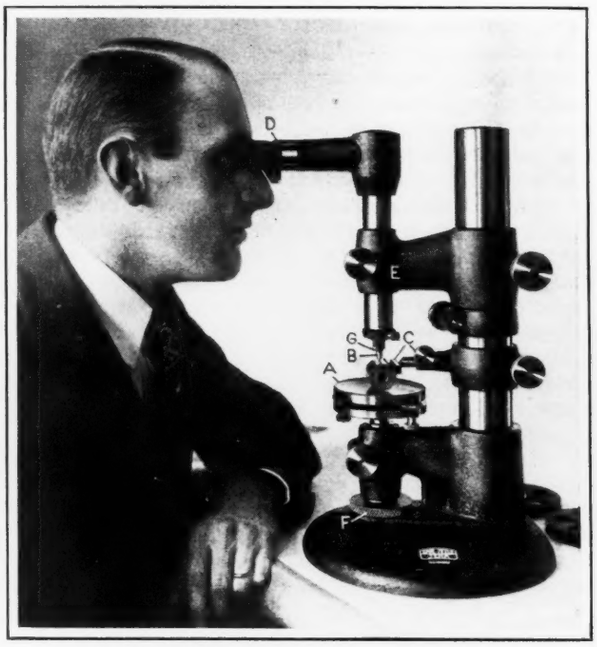


Fig. 16. Optimeter which has a Direct-reading Scale for measuring Minute Errors in Standard Gages or Precision Work

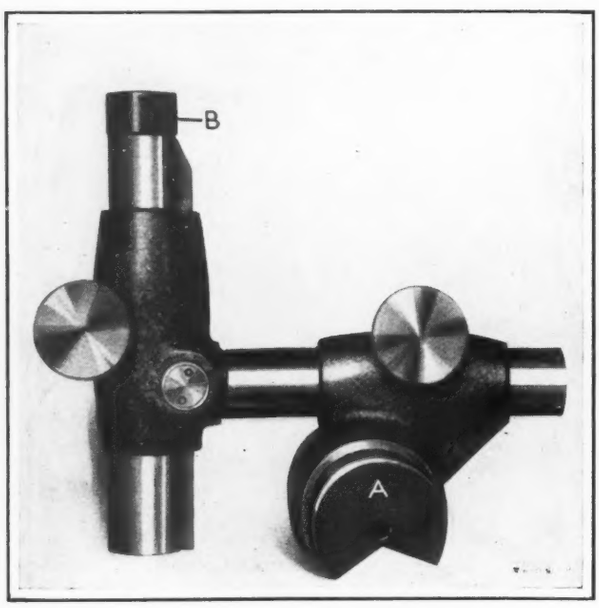


Fig. 15. Optical Gage for setting Thread-cutting Tools in Lathe

Optical Thread Tool Gage

In cutting accurate screw threads, especially on such work as gages, hobs, taps, etc., it is, of course, essential to set the thread-cutting tool so that each cutting edge inclines the same amount relative to the axis of the work. The simple form of optical gage shown in Fig. 15 is used for checking the position of the tool in the lathe. This gage consists of a base *A* to which is attached a small microscope *B* containing a glass templet on which there are V-shaped lines conforming to three standard thread angles. Two of these angles seen in the field of observation are 60 and 55 degrees, respectively, for U. S. Standard and Whitworth Standard threads, and the third angle may be either 47 degrees 30 minutes for the British Association Standard, or 53 degrees 8 minutes for the Löwenherz thread.

The method of using this optical thread tool gage is as follows: For external thread cutting, base *A* of the gage is placed either between the centers of the lathe or upon the part to be threaded, there being a V-shaped groove in the

base to provide for the latter method. The workman next adjusts the microscope to bring the top of the thread tool into focus, and then the tool is adjusted so that its cutting edges coincide with a vee of corresponding angle in the field of observation. For setting inside thread tools, the gage is aligned with the lathe axis by holding it on a special arbor having a flange at one end, the flange merely being held against a turned face on the work. The microscope or eye-piece of this gage has a magnifying power of five times.

Optimeter for Checking Gages or Precision Parts

The "optimeter," which is shown in Fig. 16, may be described briefly as an optical indicator or comparator, which utilizes a microscope for magnifying the image of an exceedingly accurate glass scale which, through suitable reflecting means, enables the observer to obtain by direct reading the difference between the measurement of whatever gage or other part is being tested and the precision gage-block or other standard used in setting the optimeter to the zero position. The illustration shows how the optimeter is used for checking the diameter of a cylindrical

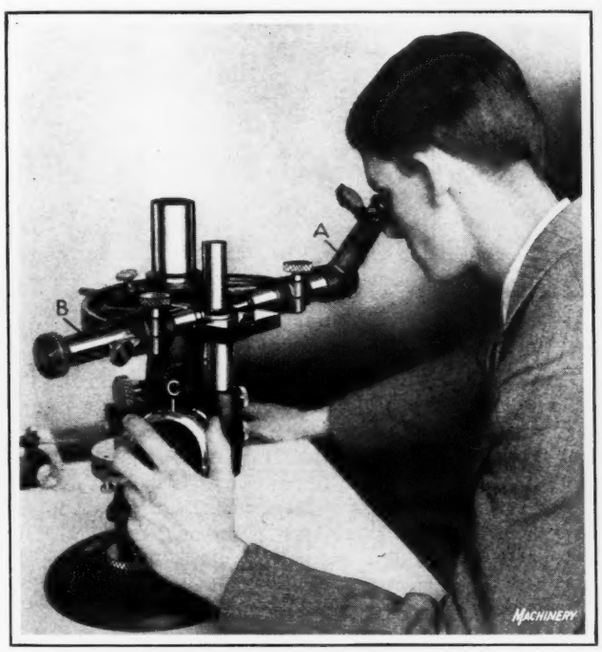


Fig. 17. Optimeter equipped with Horizontal Attachment for Convenience in measuring Certain Classes of Work

hollow pin. The pin is held between the flat table *A* and a feeler point *B*. A back-stop or support *C* is also used for such work to locate it readily directly under the feeler point.

As the observer looks into the microscope, he sees the magnified image of the graduated scale which appears in the field of observation, as represented by Fig. 20. Now if the size of the work is exactly the same as the size of the standard gage-block that was used in adjusting the instrument, the zero line of the scale will be directly opposite the fixed pointer seen at the left, whereas any variation within a total range of 0.0035 inch, plus or minus, will be shown directly by the position of the graduations relative to the pointer. The actual graduation lines on the glass scale are exceedingly fine, but the magnification enables the observer to read the scale readily and also subdivide with fair accuracy the finer divisions, which represent 0.00005 inch, or 0.001 millimeter.

Light, either from a natural or artificial source, is reflected from a small mirror through prisms and lenses downward to a mirror located just above the feeler point *B*, Fig. 16. (The upper mirror is not visible in the illustration, but is located on the left-hand side of the eye-piece at *D*.) The image of the graduated scale is reflected upward from the lower mirror into the field of observation.

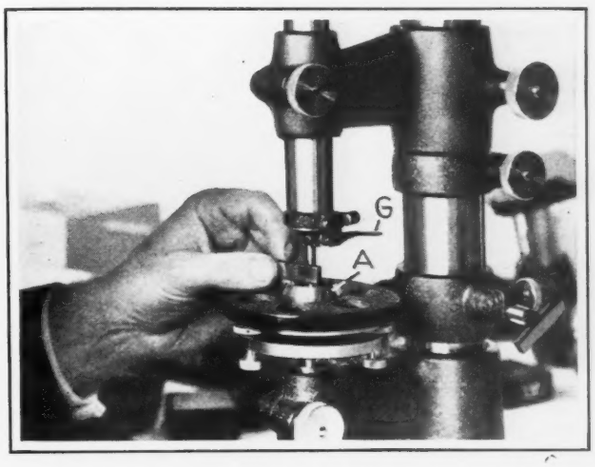


Fig. 18. Optimeter Attachment for checking Precision Gage-blocks

The lower mirror is mounted on three balls, two of which are embedded in the bottom of the mirror. The third ball is at the upper end of feeler *B*, so that any vertical movement of the feeler causes a slight tilting of the mirror, which, in turn, moves the image of the scale relative to the fixed pointer as described. The figures 5, 10, etc., opposite the main divisions on the scale represent tenths of one thousandth, the total range of the scale being 0.007 inch.

In setting the optimeter, the arm *E* is first adjusted to the approximate position vertically along the column, and then the table is raised or lowered slightly by means of a fine-pitch screw at *F*, until the zero graduation on the scale is in line with the fixed pointer when the standard gage-block is beneath the feeler point. The latter may be raised for inserting or removing a gage-block or the work, by pressing a small lever *G* (see also Fig. 18), and the feeler point always bears upon the work with a uniform pressure of a few ounces, as controlled by a spring.

The hardened table of the optimeter is lapped to an optical finish and it may be adjusted if necessary by means of three screws having spherical seats. An important feature of this instrument is that continued use does not impair the accuracy of the reading, as this depends upon the accuracy of a fixed glass scale which has been divided in the Zeiss plant by means of the most precise methods known. The optical tube may readily be removed from arm *E* if it is desired to use it in connection with special fixtures or measuring appliances. The extreme height that can be measured with the optimeter is 7 inches.

Attachments Used with Optimeter

Several different forms of attachments are used in conjunction with the optimeter. Fig. 17 shows how the horizontal attachment is employed for measuring parts that

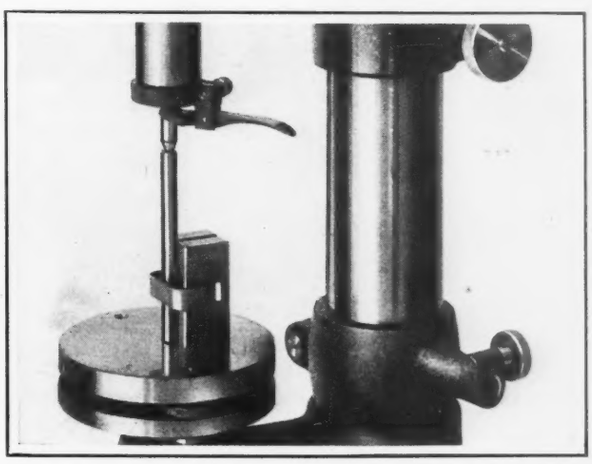


Fig. 19. Method of holding End Rods or Gages while checking with Optimeter

should preferably be placed between horizontal contact points. This attachment consists mainly of a heavy yoke which supports, in a horizontal position, the optical tube *A* on one side, and a tailstock spindle *B* on the other. The table which supports the work may be moved vertically by handwheel *C*, either for locating the work in the right position or for moving it in order to check the size at different points. This table is mounted on balls and has a free floating movement of such sensitiveness that the resistance is less than the small pressure of 7 or 8 ounces exerted by the feeler point, so that correct positioning of the work between the measuring points is insured. The vertical table movement may be limited by adjustable stops, and its position locked by the aid of a binding screw. The vertical travel of the table is 2 3/8 inches, and the maximum diameter that can be measured with standard equipment is 8 inches.

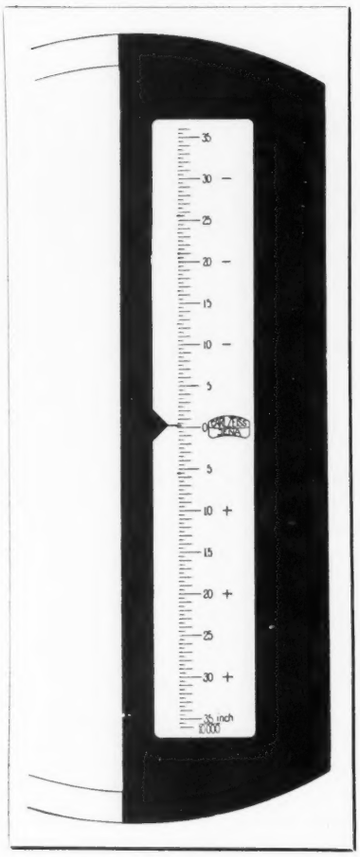


Fig. 20. Scale of Optimeter reproduced to One-half Actual Size

Special Attachments for Optimeter

One of the important uses of the optimeter is for checking precision gage-blocks or other reference standards, to safeguard against errors resulting either from wear or distortion. In handling work of this kind, if the flat table were used as a support, it would be necessary to wring the work carefully on the table, the same as two or more blocks are assembled, in order to exclude the air film of variable thickness. Fine particles of dust on the table might also cause appreciable variations.

Since the wringing action requires time and might result in straightening, temporarily, warped gages, the small auxiliary table shown in Fig. 18 has been designed for such work. The rim *A* of this table is lapped to an optical finish, and lies in the same plane as the top of an agate ball in the center. The instrument is first adjusted to the zero position by using a standard of known accuracy, and then the gage-blocks to be tested are placed between the agate ball and the feeler point, as the latter is lifted by pressing down on lever *G*. With this arrangement, flat gages may readily be checked, both in the middle and near the ends. A ball-shaped feeler cap should be used for this operation.

The attachment illustrated in Fig. 21 is intended for measuring small wires of various kinds when considerable precision is necessary. The wire to be measured is laid in the V-grooved tops of two spring-cushion steel pins *A* and *B*. Between these pins there is an accurately lapped cylindrical plug *C*, which is held in place by two flat springs. If the size of the wire is less than 0.0035 inch, the graduated scale of the optimeter is set to zero when the feeler point is in contact with the cylindrical plug, and then the wire size is read directly from the graduations. For larger wires, a standard gage-block equal to the required wire diameter, is temporarily inserted beneath plug *C*; the scale is then adjusted to zero with plug *C* in this raised position, after which the gage-block is removed, thus allowing the plug to return to its original position. Plus or minus variations in wire sizes are then shown by the graduations, which, in this case, indicate the difference between the wire size and the gage-block size.

The simple form of attachment shown in Fig. 19 is used for holding end rods or gages in a vertical position while checking the length. This attachment consists of a block containing a V-groove, in which the rod or gage is held by means of a U-shaped spring made of flat stock.

Another special attachment is illustrated in Fig. 22. This is used for gaging balls, and it merely provides a support for the ball to be tested, together with a pincer-shaped holder which enables the ball to be inserted or removed readily. When the ball is in position, it is held on an agate surface embedded in the support, and after gaging, it may be ejected over an incline by a slight motion of the lever. A feeler point having a flat face should be used.

Although the measuring tools and instruments described do not include all the optical types developed by Carl Zeiss for use in machine-building plants, they illustrate the value of the optical principle as applied to various classes of precision measuring and inspection work.

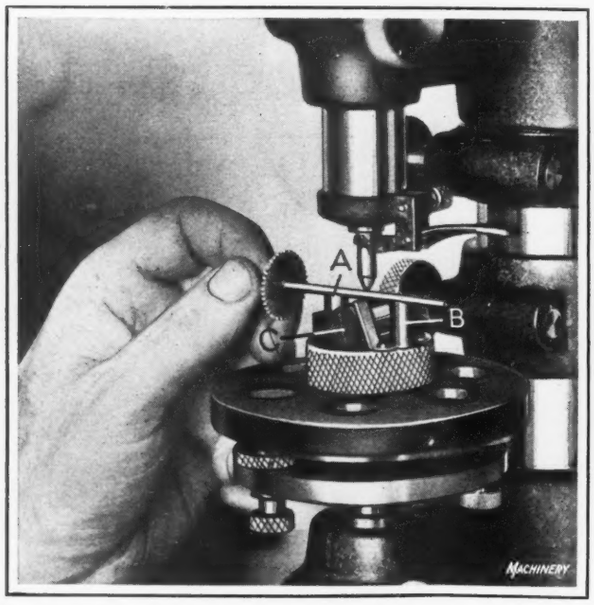


Fig. 21. Special Wire-measuring Attachment on Optimeter

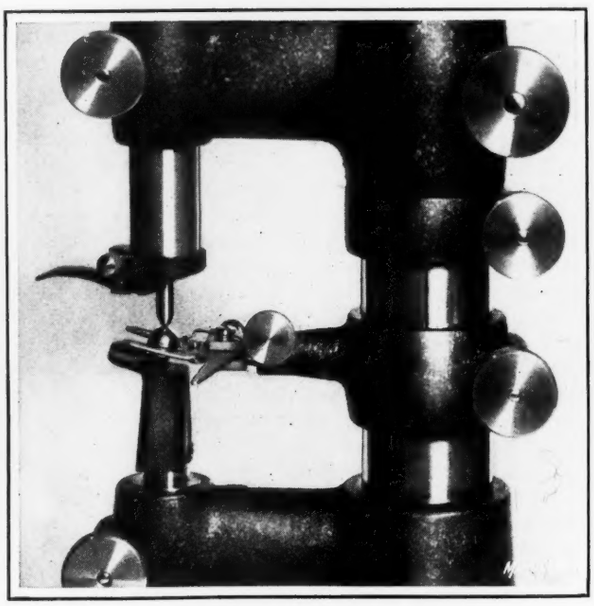
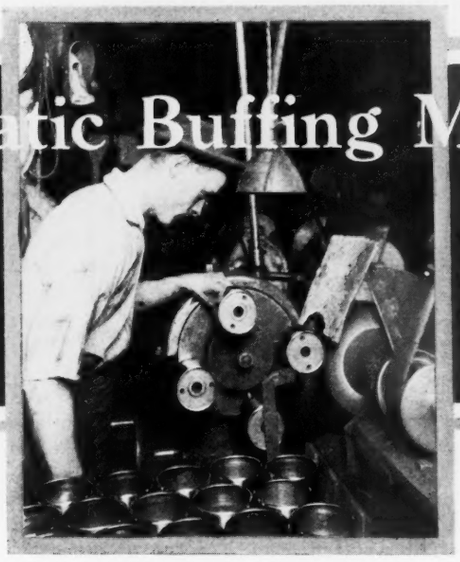


Fig. 22. Optimeter Attachment used for checking Ball Diameters

Automatic Buffing Methods

A Series of Articles Dealing with Problems Encountered in Automatic Buffing Operations



Types of Chucks Employed to Hold a Variety of Work on a Rotary Head Machine

SEVERAL methods of holding work on the type K automatic buffing machine, built by the Automatic Buffing Machine Co., Buffalo, N. Y., were described in June MACHINERY. In the designs described, the work was held by some hand-operated device. The present article will describe a number of chucks that are operated automatically by either a draw-in or a push-out rod at the center of the spindles.

Fig. 1 shows the complete arrangement of a push-out design for holding the small combination spiral gear and shaft illustrated at *A* while removing burrs from the side and top of the gear teeth with a wire wheel. The shank is simply seated in the split collet *B*, the jaws of which are automatically tightened on the shank by spring *C* when the hand of the operator is released from the work. Collet *B* is contained in holder *D*, which is clamped directly on the spindles of the rotary head of the machine, as indicated at *E*.

The forward end of spring *C* bears against the head of stem *F*, and the shank of this stem abuts against the rear end of the collet. As the spring forces the collet forward, the jaws slide along the internal tapered surface of holder *D* and are thereby compressed. The gear for driving the spindle is shown at *G*. Rod *H* which holds the unit together, has a short longitudinal movement to permit of readily pushing back the collet, stem and spring to remove a piece of work. With an eight-spindle machine equipped with chucks of this design, the production is 800 pieces per hour.

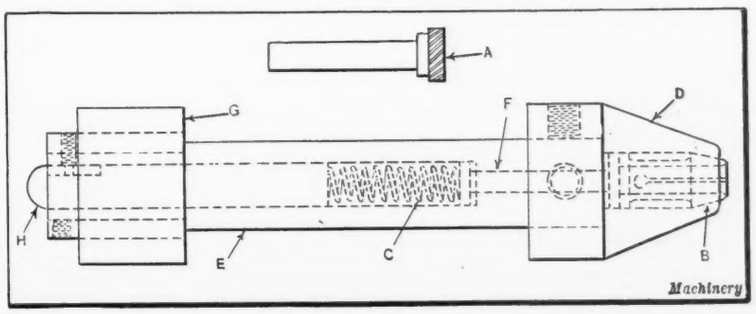


Fig. 1. Push-out Collet Chuck employed for holding the Small Combination Spiral Gear and Spindle A

A chuck used in buffing a brass reflector shell for a flashlight is shown in Fig. 2. The part is seated on a machine-steel body *A* to which a front plate *B* is attached by means of two machine screws. Held in this plate are two straight springs *C* made from music wire, and the inner end of each spring is attached to a jaw *D* which is free to slide radially. Rod *F* is screwed into the forward end of rod *H*, which is of about the same construction as rod *H*, Fig. 1.

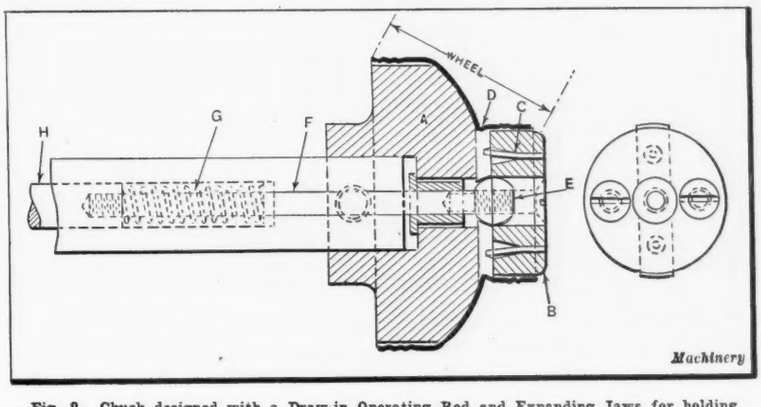


Fig. 2. Chuck designed with a Draw-in Operating Rod and Expanding Jaws for holding a Flashlight Reflector Shell

When the back end of rod *H*, Fig. 2, leaves the cam mentioned in connection with Fig. 2 of the preceding article, coil spring *G* is free to expand and pull back rods *H* and *F* so that the tool-steel ball *E* on the forward end of rod *F* is moved longitudinally to expand jaws *D*. These jaws have a groove in them that registers with a groove in the periphery of the work and thus holds it securely for the buffing. Springs *C* pull the jaws toward the center of the chuck when rod *H* again contacts with the cam. In this operation, an eight-spindle machine is set for polishing 450 parts per hour.

Chucks with Swinging Jaws

An interchangeable feature which enables the same chuck to be used for various sizes of work is incorporated in the chuck illustrated in Fig. 3. This design consists of a main body *A* and a hinged member *B*. Attached to part *B* and the body are hardened steel segments *C* and *D*, respectively, and these are interchangeable for different sizes of work, as indicated by the dotted lines. The work is slid into place on these segments, while the back end of a rod corresponding to rod *H*, Fig. 2, is contacting with the cam on the machine. Then when the rod is released from the cam and ball *E* is pulled back, the hinged member and segments *C* are swung outward to grip the work on an inside surface. When rod *F* is again forced forward, a small coil spring insures the release of part *B* from the work. The parts *C* and *D* as represented by the solid lines are used for a piece of work about 2 inches in diameter which may be buffed on the edge and face in two operations. The production on an eight-spindle machine is 400 pieces per hour

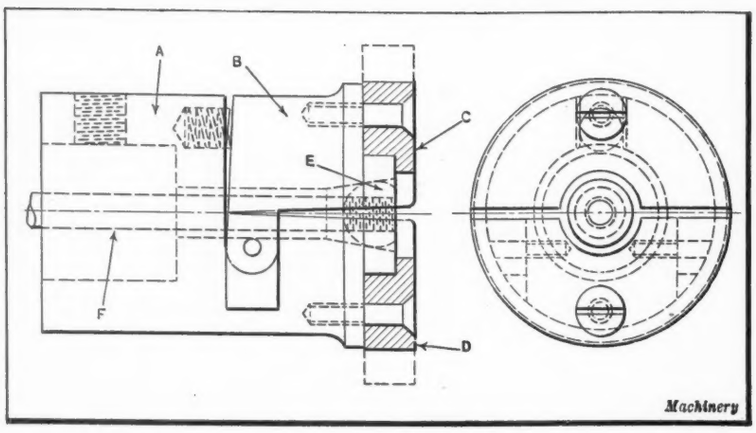


Fig. 3. Interchangeable Chuck Construction which may be used for holding Various Sizes of Work of the Same Type

For chucking a steel speedometer spindle, about 2 1/4 inches long and 1/4 inch maximum diameter, the hinged jaw design illustrated in Fig. 6 is used. Two polishing operations are performed on this part, one with the wheel applied as shown, and the other with the wheel against the end of the knurled portion. When rod *F* is pulled back, ball *E* expands the inner ends of jaws *A* and thus causes the outer ends to move in and grip the work. The jaws are hinged in part *B*, which is screwed into the chuck body. Set-screws *C* act as stops for the jaws. The work contacting surface of each jaw is hollowed out to suit, and the jaws are made of tool steel and hardened. In both operations performed on this piece of work, a production of 900 pieces per hour is obtained with an eight-spindle machine.

Another chuck designed on the same principle as the one just described, but intended for holding larger work is shown in Fig. 4. There are three hinged jaws *A* contained in body *B*, the outer ends of which are swung toward the center of the chuck when ball *E* contacts with the central end of the jaws as rod *F* is pulled back. The work is then gripped on a flange about 2 inches in diameter. An eight-spindle machine equipped with chucks of this design can be set for producing 800 pieces per hour, the work being particularly well supported where the wheel is applied.

A sectional view of another chuck of the same general design is shown in Fig. 5. This chuck is used for holding a steel shell about 2 inches in diameter and 5/8 inch deep, which is buffed on surface *X*. In this design, the forward end of each of the three jaws *A* swivels on the work as collar *C* contacts with the surface of the jaws that is at right angles to the axis of the chuck proper. The work seats on part *B*, and is ejected by the circular pad *D* when rod *F* is again moved forward to permit reloading the work. An eight-spindle machine equipped with this chuck produces 800 parts per hour.

Chuck with Cork Grips

The chuck illustrated in Fig. 9 was developed for holding a hollow cylinder about 5 inches long and 1 1/2 inches in diameter. Body *A* is an aluminum casting in which there are two slots diametrically opposite each other that contain hard wood blocks *B*. These blocks are faced with cork on the outer surface which contacts with the inside of the work, and they are mounted on flat springs attached to the body. When ball *E* and rod *F* are drawn back, the ball forces the blocks against the work, holding it firmly for the operation, which is wire brushing. Then when the rod and ball are returned as the spindle rod again reaches the cam on the machine, the flat springs pull the blocks toward the center of the chuck and release the work. The function of pin *C* is to center the work on the chuck. This aluminum tube is satin finished on an eight-spindle machine set for a production of 400 pieces per hour.

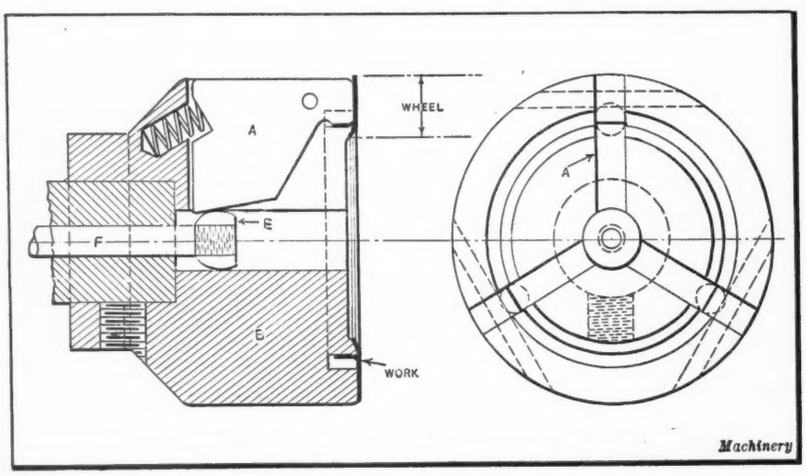


Fig. 4. Chuck with Swinging Jaw Construction used in gripping Work on a Flange about Two Inches in Diameter

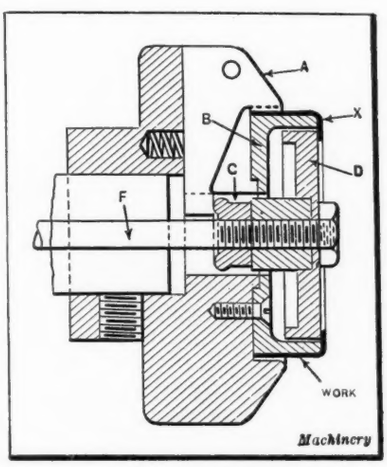


Fig. 5. Design using a Collar instead of a Ball for swinging the Jaws

Probably the most unique of all the draw-in chucks described is that shown in Fig. 7. This chuck is employed to hold a hollow ball-end brass knob, which is buffed practically all over, as indicated by the position of the wheel. The work is held by expanding the front end of the split part *A* which is machined to fit the inside of the work at the neck. The expansion is accomplished by means of a plug *B* which is attached to rod *F* by means of a piece of piano wire *E*. Both halves of part *A* are held in body *C* by means of a flange at the rear end, and prevented from turning by two pins *D*. A coil spring *G* bears on each half of part *A* so that the halves are compressed when rod *F* is pushed forward and thus permit the work to be easily removed.

Bushing *H* and parts *A* and *B* are made of tool steel and hardened. The end of wire *E* that is attached to rod *F* is

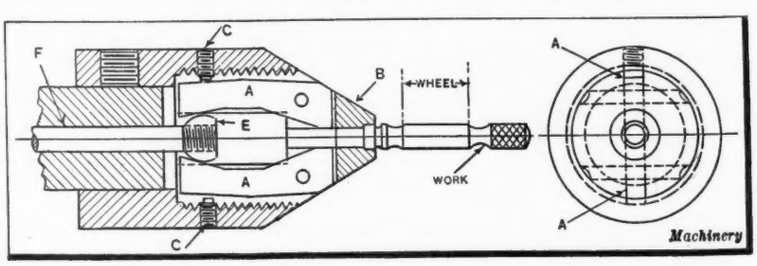


Fig. 6. Chuck with Two Swinging Jaws which is used in buffing a Part of Small Diameter

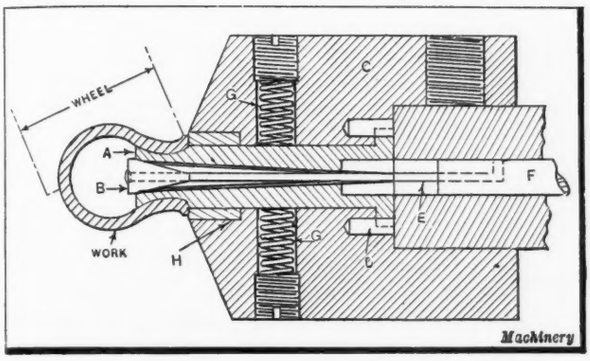


Fig. 7. Draw-in Chuck employed in buffing the Entire Exterior Surface of a Ball-end Brass Casting

burred and then squeezed in place, to insure that it will not be pulled out. The other end of the wire is riveted on the head of plug *B*. Four hundred pieces per hour are buffed in an eight-spindle machine equipped with chucks of this design.

Fig. 8 shows a chuck developed for holding a hame ball such as is used on horse collars. This part is a brass casting and naturally somewhat rough on the inside. After the work has been slipped on body *A*, handwheel *B* is revolved to push rod *C* forward. Contacting with the tapered portion of this rod are three pins *D* that are equally spaced around a circle. Hence, as rod *C* is advanced, these pins move radially outward and grip the inside of the work to keep it from rotating. In addition, the front end of the work is held against body *A* by a holder *E* which is hollowed out to suit. Such a holder for each spindle is contained on a plate attached to the rotary head. The holders are swiveled on and off the work by hand.

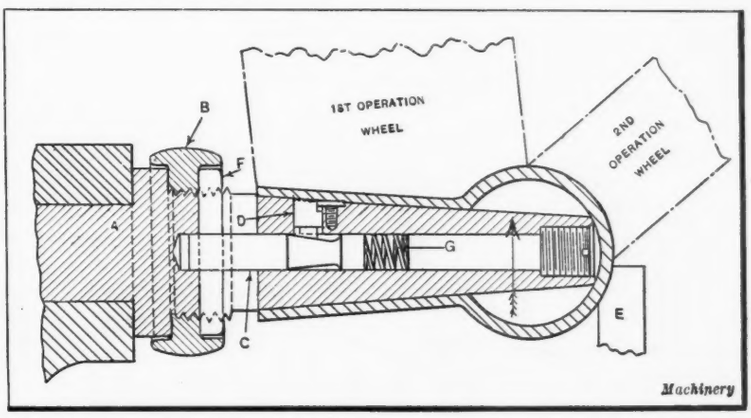


Fig. 8. Hand-operated Chuck used for holding Another Ball-end Casting in Two Polishing Operations

One side of pins *D* is flattened, and a thin plate contacts with this surface to keep the pin from turning. The end of the pins that contacts with the work is serrated to insure a good grip. Rod *C* carries a pin *F* which is held in contact with the handwheel by spring *G*. This type of chuck requires a longer time for reloading than chucks automatically operated; nevertheless a production of 250 pieces per hour is obtained with an eight-spindle machine.

* * *

A new type of locomotive, stated to be capable of developing one-third more power with one-third less consumption of fuel and water, has been placed in service by the Delaware & Hudson Co. The new locomotive has been named *Horatio Allen*. The reason for the unusual economy claimed for this type of engine is found in the fact that steam of very high pressure is employed. The construction of the engine required many changes from conventional designs, on account of the high steam pressure. The performance of the new locomotive will be watched with great interest by engineers engaged in the transportation field.

TRADE ASSOCIATION ACTIVITIES APPROVED

The decisions recently handed down by the Supreme Court of the United States relating to trade associations will have a far-reaching effect on the service of trade associations in many industrial fields. According to this decision, trade associations do not violate the anti-trust laws in gathering and disseminating among their members information as to costs, quantity of production, stock on hand, and sale prices. In expressing the majority opinion of the Court, Associate Justice Stone declared: "It is not open to question that the dissemination of pertinent information concerning any trade or business tends to stabilize that trade or business and to produce uniformity of price and trade practice. * * * But the natural effect of the acquisition of wider and more scientific knowledge of business conditions on the minds of the individuals engaged in commerce and its consequent effect in stabilizing production and price can hardly be deemed a restraint of commerce. * * *

"It was not the purpose or the intent of the Sherman Anti-trust Law to inhibit the intelligent conduct of business operation, nor do we conceive that its purpose was to suppress such influence as might affect the operations of interstate commerce through the application to them of the individual intelligence of those engaged in commerce, enlightened by accurate information as to the essential elements of the economics of a trade or business, however gathered or disseminated.

"We decide only that trade associations or combinations of persons or corporations which openly and fairly gather and disseminate information as to the cost of their product, the volume of production, the actual price which the product has brought in past transactions, stocks of merchandise on hand, approximate cost of transportation from the principal point of shipment to the points of consumption, as did these defendants, and who, as they did, meet and discuss such information and statistics without, however, reaching or attempting to reach any agreement or any concerted action with respect to prices or production or restraining competition, do not thereby engage in unlawful restraint of commerce."

* * *

According to a recent Commerce Report, plans and specifications have been practically completed for the construction of a viaduct which is to carry the tracks of the Canadian National and Canadian Pacific Railways overhead through the center of the city of Toronto. The estimated cost of this project is $28,000,000.

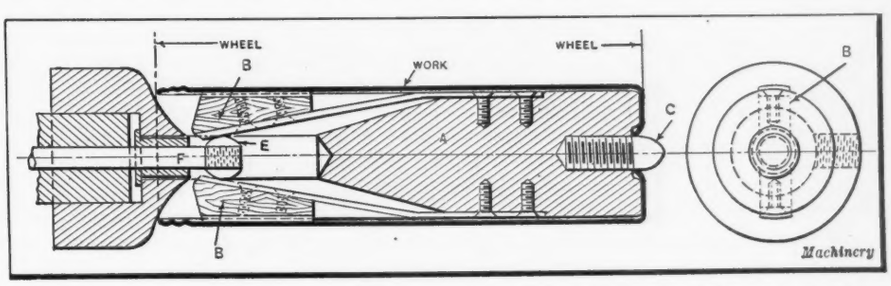


Fig. 9. Design in which Use is made of Two Hard-wood Cork-faced Blocks for gripping the Inside of a Long Hollow Cylindrical Part

GROUND FLAT STOCK

By HAROLD B. SCHOTT

Although ground flat stock has been manufactured for several years, it has not yet come into general use, and its advantages do not appear to be fully appreciated. The price of ground flat stock, when compared with that of a piece of steel of the same size and quality, appears rather high; yet if we consider the number of operations necessary to prepare it for the market and the amount of labor it saves when properly used, the cost is reasonable. In fact, manufacturing costs have actually been lowered by the proper use of ground flat stock. For those who are not familiar with this material, the following information will prove of interest.

The outer appearance of ground flat stock is the same as that of any stock that has been ground. The material is a fine quality tool steel, and the stock is cut to a certain size, annealed, and then accurately ground to insure uniform thickness. The edges of the stock are milled and ground to insure parallelism. As made by a leading manufacturer, it comes in lengths of 18 inches and in over 100 sizes of widths and thicknesses. The tool steel used for this stock contains from 1.10 to 1.20 per cent carbon. The thicknesses usually run from 1/64 to 3/8 inch, and the widths from 5/16 inch to 6 inches in about ten sizes. Ground stock is also made in square-section bars 1/4, 1/2, 5/16, 3/4, 3/8, and 1 inch square. These sizes are kept in stock, but other sizes may be obtained on special order.

One of the advantages of ground flat stock is its accurate and uniform thickness, which by a special grinding process is held within a limit of 0.001 inch. The stock is also uniformly annealed before it is ground, thus eliminating any hard spots that may make accurate machine work difficult.

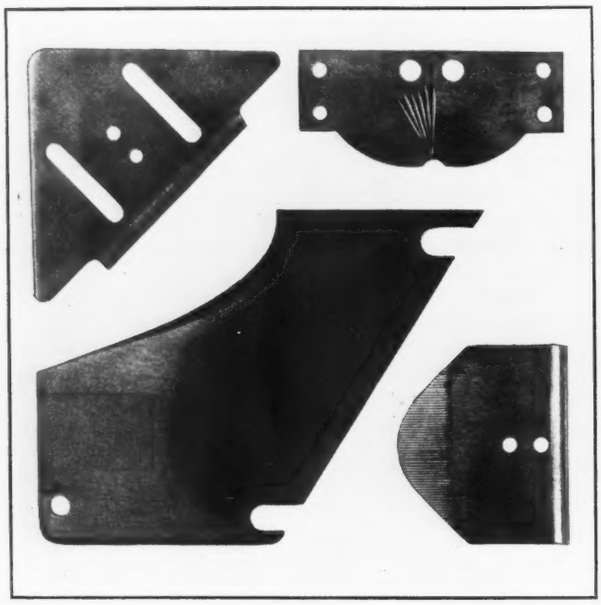


Fig. 1. Parts of Shoe Machinery, produced from Ground Flat Stock

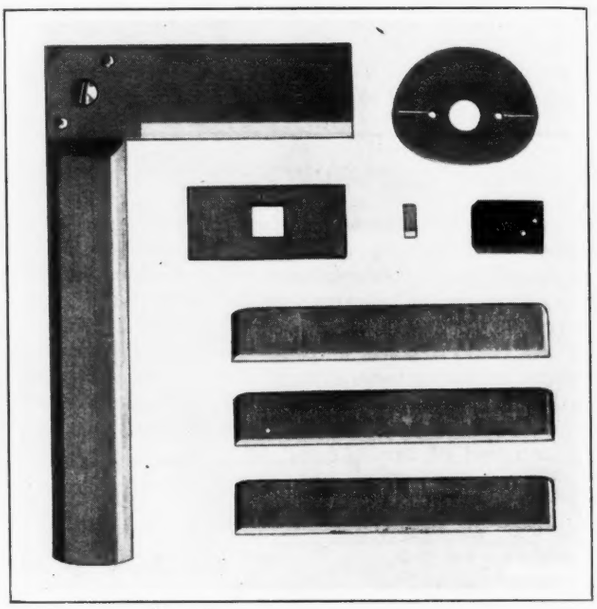


Fig. 2. Parts made from Ground Stock by Manufacturer of Optical Equipment

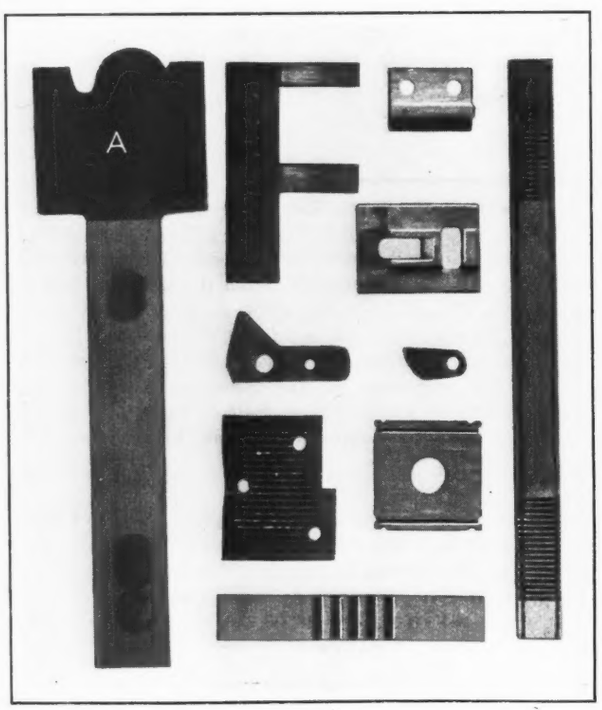


Fig. 3. Forming Tool, and Parts for Bottling Machine

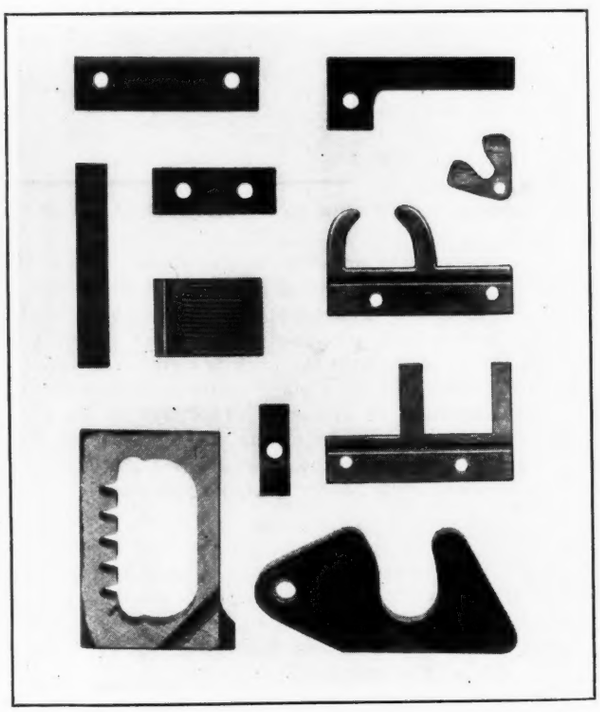


Fig. 4. More Parts used in Bottling Machines

Where Ground Stock is Used

Ground flat stock is used in almost every line of manufacture. Duplicate parts that are made in large quantities and that must be accurate as to thickness can generally be produced cheaper from ground flat stock than by grinding regular stock to the required size. Toolmakers use this material for flat gages, parallels, die work, jigs, fixtures, stamps, and cutters. One of the reasons that toolmakers prefer to use ground flat stock for this kind of work is that it is difficult to grind flat stock without overheating and distorting it, especially when the work requires stock of the thinner size.

How Ground Stock is Used

When ground stock is used, the part to be made is laid out on stock of the required thickness, thus eliminating the necessity of grinding the work solely to obtain the exact thickness. The machine work required to cut the piece from the flat stock is then done in the usual manner. Costly surface grinding, with the danger of overheating and distorting the piece, is thus avoided.

The special equipment that is used to grind the stock to size produces a very good finish with a high degree of accuracy. The edges of the pieces are also ground so that they may be used as parallels. The accompanying illustrations showing parts made from ground flat stock give a good idea of the variety of uses to which it is put by various manufacturers.

In Fig. 1 are shown several machine parts made from ground flat stock by a large manufacturer of shoe machinery. All of these parts are of uniform thickness, and no matter in what quantities they are produced, the manufacturer is assured that all parts will be interchangeable so far as thickness is concerned. In producing these parts, it is only necessary to perform such operations as drilling and outlining after the pieces have been cut from the stock.

Fig. 2 illustrates some of the parts made from ground flat stock by a leading manufacturer of optical equipment. At *A*, Fig. 3, is shown a forming tool made by a machine tool manufacturer for special work. The other parts shown in Fig. 3, as well as those shown in Fig. 4, are used in bottling machines of intricate design. These parts are required to be of uniform thickness and must be held within close limits of accuracy.

* * *

BUSINESS IS REGULATING ITSELF

Twenty-nine manufacturers of sheet steel recently decided to discontinue the manufacture of sheets used for roofing which are too light in weight to take an adequate galvanized coating to resist exposure for a long time. The same standards have been applied to conductor pipe and eaves trough. Manufacturers of hot water storage tanks and brass traps have agreed upon certain quality standards, and brand their products accordingly.

Manufacturers of hollow building tile, who had under competitive stress "skimped" the weight of their products so that they were unfit for use, have agreed upon standard weights which are a guarantee to the customer. Similarly, manufacturers of metal lath have adopted weight standards as a substitute for gage standards. Under the latter, unscrupulous manufacturers could reduce the weight by enlarging the mesh openings. This practice is prevented by the adoption of the new standards.

Manufacturers of terne plate used for roofing have decided upon the discontinuance of the production of certain grades which were often substituted by jobbers for higher grades with a better protective covering. The adoption of standard or substance weights by paper manufacturers has gone far to eliminate such piratical practices as cut weights, short count, and other misrepresentations.—*Chamber of Commerce of U. S.*

GRINDING FIXTURES FOR MAGNETIC CHUCKS

By S. W. BROWN

Surface grinding has been found a desirable method of finishing the faces of bronze thrust washers or similar work, but considerable difficulty is generally experienced in providing a satisfactory work-holding device. The plates shown in Fig. 1 with V-notches of different sizes cut on the four sides, when used in connection with a magnetic chuck, have proved very useful in holding bronze thrust washers like the one shown at *B*. The V-notches are beveled, as indicated at *A*, and the sharp edge is placed uppermost against

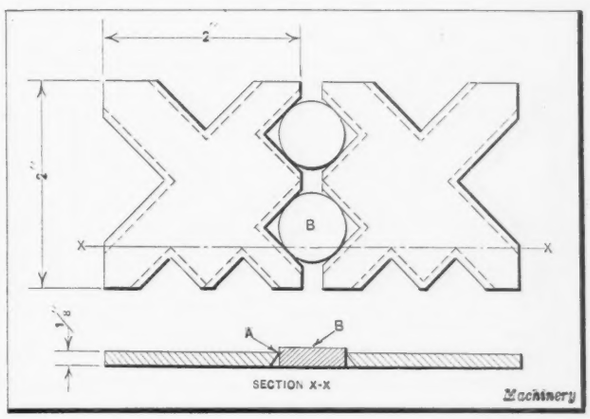


Fig. 1. Plates for holding Thin Bronze Washers on Magnetic Chuck while grinding

the work. The different notches permit the plates to be used for a wide range of sizes. The work *B* is placed on a magnetic chuck and pinched between the V-notches while the switch is being turned on. The grinding may then be done without any delay or annoyance being caused by the sliding or rotating of the work upon the chuck.

In Fig. 2 is shown a fixture designed for use in grinding the beveled edges of gibs or similar parts. This fixture consists of the outer members *C*, which are of steel, the inner part *D*, and the clamping screws and dowels, which are of brass. The included angle of the vee, although shown as 90 degrees in the illustration, may be made any angle required, or the sides need not have the same angle, as the work rests only on one side, the other serving simply as a stop.

In some cases one side may be made square, as shown at *F*. The latter type of fixture can be used to advantage in grinding rectangular work. In placing the fixture on the magnetic chuck, care should be taken to see that the lands *E* are located in positions that give the greatest holding power. This fixture can, of course, be used only for work made of iron or steel.

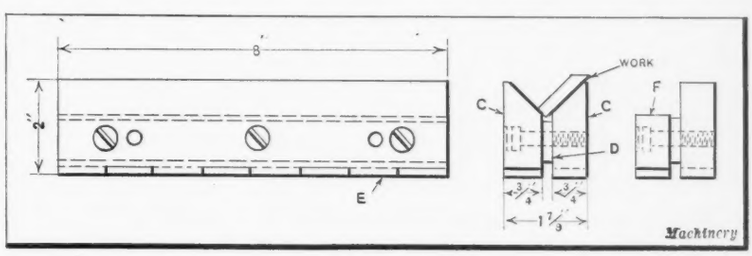


Fig. 2. Fixture for holding Iron or Steel Parts on Magnetic Chuck while grinding

* * *

In speaking before the convention of the Associated Advertising Clubs of the World, Herbert Hoover said: "The greatest single addition to our living standards in a generation has been the automobile. It has increased our national efficiency, stretched our national vision, improved our national health, and it has added some per cent of sheer joy, some dangers, and much excitement to daily life."

Detachable Link-chain Drives

By GEORGE G. DANA, Chief Draftsman, J. I. Case Threshing Machine Co., Racine, Wis.

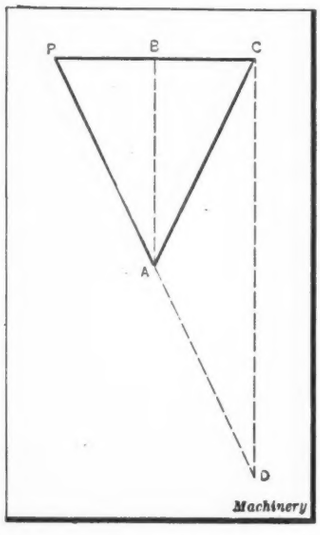


Fig. 1. Diagram showing Relation of Pitch of Chain Links to Pitch Diameter of Sprocket

AMONG the methods of transmitting power, the detachable link chain or link belt has an important place. In the past, many drives of this type were improperly designed and consequently unsatisfactory in operation, but in recent years engineers and designers have given this method careful consideration, with the result that more efficient and satisfactory drives have been produced.

The chain drive has an advantage over belt, rope, or friction drives in that there is no slippage or loss of motion between the driver and the driven shafts. Chain drives, therefore, may be classed as positive drives, similar in this respect to gearing. The ease with which a detachable link chain may be coupled together, links taken out or added, etc., are features that commend its use in many instances. Comparatively little has been written on the designing of detachable link chain or link belt drives, and for that reason the information presented in this article should be of interest to MACHINERY'S readers.

Determining the Pitch Diameter of Sprockets

For the satisfactory operation of detachable link chains, it is important that the sprockets over which they run shall be properly designed as to pitch diameter, shape of teeth, etc. The pitch diameter of a sprocket (especially sprockets having a small number of teeth) must not be figured in the same way as that of a gear based on the circular pitch. In this calculation, the pitch length of the chain links must be considered as a chord, whereas the pitch is considered as an arc in calculating gearing.

In calculating chain sprockets, the pitch-length chord equals the side opposite the apex of an isosceles triangle, the apex angle of which depends upon the number of teeth in the sprocket under consideration. In Fig. 1, *PC* represents the pitch of a chain and *PA* the radius of the pitch circle. It will be noted that triangle *PAB*, in which *PB* equals one-half the pitch, is similar to triangle *PDC* in which *PD* represents the pitch diameter of the sprocket. The pitch diameter is the first value to be sought in the calculation of a sprocket, after the number of teeth has been determined.

Angles *PAB* and *PDC* each equal one-half angle *PAC*, the latter being equal to 360 degrees divided by the number of teeth (*N*) in the sprocket. Hence, angles *PAB* and *PDC* equal 180 degrees divided by the number of teeth. From the foregoing it will be readily understood that $\sin PDC = \frac{PC}{PD}$. Transposing, $PD = \frac{PC}{\sin PDC}$. As $\sin PDC$ equals $\sin (180 \text{ degrees} \div N)$,

$$\text{Pitch diameter of sprocket} = \frac{\text{Pitch of chain}}{\sin (180 \text{ degrees} \div N)}$$

Assume that it is required to find the pitch diameter of a 10-tooth sprocket for No. 42 steel chain, the pitch of which is 1.375 inches. Then

$$\text{Pitch diameter} = \frac{1.375}{\sin (180 \text{ degrees} \div 10)} = \frac{1.375}{0.3090} = 4.4498$$

inches

If this sprocket is to be a driver, the pitch diameter calculated should be increased a small amount, and if it is to be driven, the pitch diameter should be reduced a small amount, for reasons that will be explained in the following.

Reasons for Increasing the Pitch Diameter of Drivers

If the pitch of the chain and the pitch of the sprocket teeth were equal, the sprockets free from imperfections and always true to size, and the chains exactly uniform in pitch and constant in their original length, it would not be necessary to depart from the calculated pitch diameters of driving and driven sprockets. However, these ideal conditions never exist in actual practice. Sprockets are molded in sand without any finishing cut being taken on the rims, and so there are variations in diameter and imperfections in the teeth. Furthermore, chains become longer due to wear at the joints, even under the best of treatment.

Naturally, the sprocket design must be such as will take care of conditions as they exist in practice. It has been

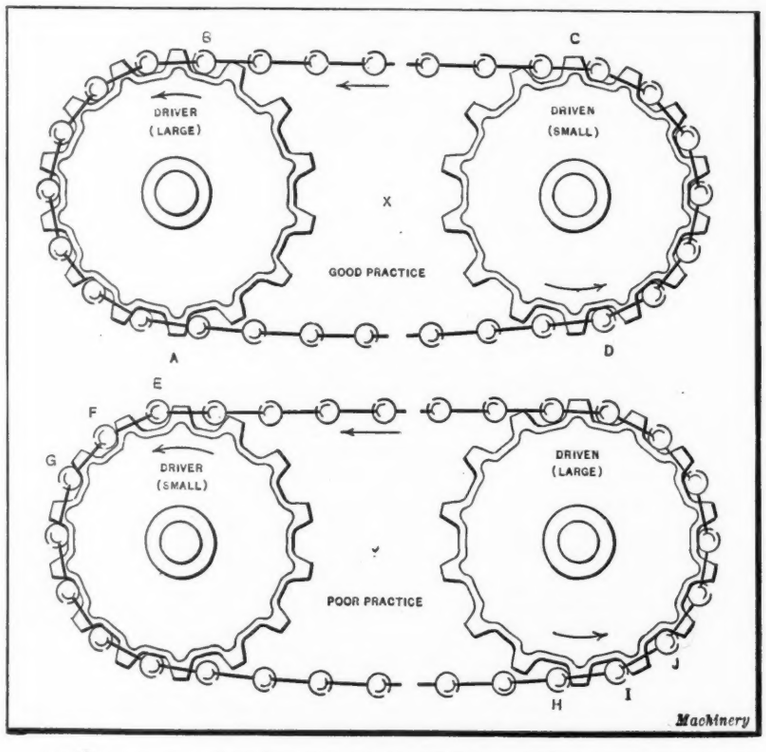


Fig. 2. Diagrams illustrating Action of Chain under Two Different Combinations of Driving and Driven Sprockets

found that by increasing the pitch of the driving sprocket, the detrimental effects due to wear of the sprocket, elongation of the chain, irregularities in molding, etc., are reduced to the minimum. Some of the reasons for this may be understood by reference to the diagram shown at *X*, Fig. 2, where the pitch diameter of the driving sprocket is slightly over size. Tooth *A* is doing the driving, but will soon release the chain to the next tooth, the successive teeth taking up the load as the sprocket revolves. The shape of the teeth is such that the release of the chain takes place without resistance and with a minimum amount of wear on the chain and teeth.

Following the chain around the sprocket, it will be noticed that there is a gradually increasing space between the hook of the chain and the working face of the tooth. The maximum amount that the sprocket can be made over size is reached when the space to the right of the hook in position *B* is zero. It will be readily seen that it would not be practical to make this space zero, as that condition would cause interference in case of irregularities in the sprocket or chain. Therefore, it is advisable that the approaching hook *B* of the chain should come in contact with the rim, or the root of the teeth, at a point about midway between the two teeth. To obtain this condition, the pitch diameter of the sprocket would be increased approximately 1/16 inch for the chains in most common use. With small chains, say No. 25 and smaller, the amount would be less, and with large chains, say No. 62 and over, the amount would be greater.

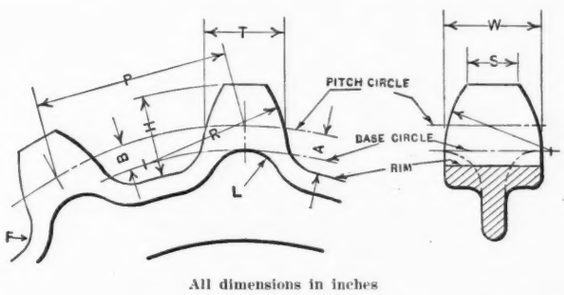
Some consideration must be given to the molding of the castings; for instance, a carefully machine-molded sprocket will come more accurately to the size of the pattern than one carelessly molded by hand. Consequently, the accurately molded sprocket will admit of a larger over-size allowance in making the pattern, than one that is carelessly molded. It must also be borne in mind that castings usually come larger than the intended size rather than smaller, regardless of the care taken in molding.

Why the Pitch Diameter of Driven Sprockets should be Made Under Size

Now let us consider the driven sprocket shown at *X* in Fig. 2, the pitch diameter of which is slightly under size. Tooth *C* is carrying the load. The tooth that is entering the chain at the bottom should have just enough clearance to allow it to enter freely under various conditions, and so the difference between the calculated pitch diameter and that of the pattern should be such as to bring about this condition. Thus, the amount that the pitch diameter should be reduced on the driven sprocket should be only enough to take care of variations in the diameter of castings. With good foundry practice, the amount should not be more than 1/32 inch, while under less favorable conditions it might be well to allow 1/16 inch.

Elongation of the chain, due to wear at the joints, etc., improves the action of the chain on over-size driver sprockets until a certain point is reached where the pitch of the chain links becomes greater than the pitch of the sprocket. Then there will be a tendency for the chain to "climb" on the entering teeth, as shown at *E* in the diagram *Y*. Elongation of the chain has little effect on the action of the driven sprocket until it reaches an amount that causes hook *D*, diagram *X*, to come in contact with the idle face of the entering tooth, after which there will be excessive wear produced by slippage of the chain on the teeth as well as by the tendency of the chain to climb.

TABLE 1. DIMENSIONS OF SPROCKET TEETH FOR STEEL DETACHABLE-LINK CHAINS



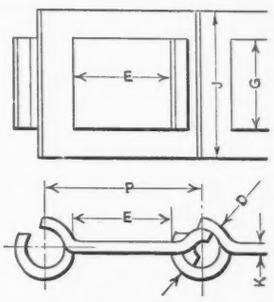
All dimensions in inches

Number of Chain	Pitch of Chain P	Pitch Circle To Rim A	Pitch Circle To Base Circle B	Face Radius R	Fillet Radius F	Height of Tooth H	Thickness of Tooth on P.C. T	Width of Rim W	Width of Point S
25	0.90366	0.178	1/8	11/16	1/8	3/8	5/16	11/32	3/16
32	1.15745	0.219	1/8	7/8	3/16	15/32	7/16	1/2	1/4
42	1.37500	0.260	5/32	1 1/16	7/32	9/16	9/16	11/16	3/8
45	1.63007	0.295	3/16	1 1/4	1/4	5/8	5/8	11/16	3/8
52	1.50781	0.300	3/16	1 1/8	1/4	5/8	5/8	3/4	13/32
55	1.63007	0.310	3/16	1 1/4	1/4	5/8	5/8	11/16	3/8
62	1.64554	0.344	3/16	1 1/4	5/16	11/16	11/16	7/8	9/16

Machinery

TABLE 2. DIMENSIONS OF STEEL DETACHABLE-LINK CHAINS

(Standards of the Locke Steel Chain Co.)



All dimensions in inches

No. of Chain	Pitch of Chain P	Dia. of Hook D	Length of Opening E	Width of Opening G	Width Overall J	Thickness of Metal K
25	0.90366	0.355	0.549	27/64	45/64	0.073
32	1.15745	0.437	0.703	19/32	15/16	0.090
42	1.3750	0.520	0.845	25/32	1 7/32	0.105
45	1.63007	0.590	1.020	25/32	1 7/32	0.105
52	1.50781	0.600	0.900	27/32	1 13/32	0.120
55	1.63007	0.620	1.000	51/64	1 9/32	0.125
62	1.64554	0.687	0.953	63/64	1 9/16	0.148

Machinery

What Happens When the Driver is Under Size and the Driven Sprocket Over Size

In diagram *Y*, the driver is under size and the driven sprocket over size. With this arrangement, when the entering teeth of the driver take up the load, since the pitch of the chain is greater than that of the sprocket, the chain links do not seat themselves properly on the rim of the sprocket. Thus there is a tendency for them to climb on the teeth, as shown at *E*, *F*, and *G*, and also a slipping action on the driving face of the teeth and on the rim. Consequently, there is excessive wear on both the chain and the sprocket and undue tension in the chain.

With the over-size driven sprocket, the entering teeth are the ones that transmit the load from the chain to the sprocket. Here the chain pitch is less than that of the sprocket, which condition does not allow the chain to seat itself properly on the rim, as it comes in contact with teeth *H*, *I*, *J*, etc. This results in a tendency

for the chain to climb on the entering teeth and cause excessive wear, as in the case of the driving sprocket. The chain must crawl on the rim as the sprocket revolves, and as the chain is in tension from hook *I* to hook *E*, there is wear on the back of the chain links and on the rim of the sprocket. The detrimental effects of an over-size driven sprocket will continue until elongation of the chain and wear of the sprocket have equalized the pitch of the chain and that of the sprocket, after which the chain should run satisfactorily. With the under-size driver, there is no chance of improvement, as the elongation of the chain and wear of the sprocket only aggravate the action.

TABLE 3. NORMAL PITCH DIAMETERS OF SPROCKETS FOR STEEL DETACHABLE-LINK CHAINS

Number of Teeth	Number and Pitch of Chain					
	No. 25 0.90366	No. 32 1.1574	No. 42 1.3750	No. 52 1.5708	Nos. 45 and 55 1.6301	No. 62 1.6455
5	1.537	1.969	2.339	2.565	2.773	2.799
6	1.807	2.315	2.750	3.016	3.260	3.291
7	2.083	2.668	3.169	3.475	3.757	3.793
8	2.361	3.025	3.593	3.940	4.260	4.300
9	2.642	3.384	4.020	4.408	4.766	4.811
10	2.924	3.745	4.449	4.879	5.275	5.325
11	3.207	4.108	4.880	5.352	5.786	5.841
12	3.491	4.472	5.312	5.826	6.298	6.358
13	3.776	4.837	5.746	6.301	6.811	6.876
14	4.061	5.201	6.179	6.776	7.325	7.395
15	4.346	5.567	6.613	7.252	7.840	7.915
16	4.632	5.933	7.048	7.729	8.355	8.435
17	4.918	6.299	7.483	8.206	8.871	8.955
18	5.204	6.665	7.918	8.683	9.387	9.476
19	5.490	7.032	8.354	9.161	9.904	9.986
20	5.777	7.399	8.790	9.639	10.420	10.519
21	6.063	7.766	9.226	10.117	10.937	11.041
22	6.350	8.133	9.662	10.595	11.454	11.563
23	6.637	8.501	10.098	11.074	11.972	12.085
24	6.923	8.867	10.534	11.551	12.488	12.607
25	7.210	9.235	10.971	12.031	13.006	13.130
26	7.497	9.602	11.407	12.509	13.523	13.651
27	7.784	9.970	11.844	12.988	14.041	14.175
28	8.071	10.337	12.280	13.466	14.558	14.696
29	8.358	10.705	12.717	13.946	15.076	15.220
30	8.645	11.073	13.154	14.425	15.594	15.742
31	8.932	11.441	13.591	14.904	16.112	16.265
32	9.220	11.809	14.029	15.384	13.632	16.789
33	9.506	12.176	14.464	15.862	17.148	17.310
34	9.795	12.545	14.903	16.343	17.668	17.836
35	10.082	12.914	15.341	16.823	18.187	18.359
36	10.368	13.280	15.776	17.299	18.702	18.879
37	10.655	13.648	16.213	17.779	19.220	19.403
38	10.943	14.016	16.650	18.259	19.739	19.927
39	11.231	14.385	17.089	18.740	20.259	20.452
40	11.517	14.752	17.525	19.217	20.776	20.973
41	11.805	15.120	17.962	19.697	21.294	21.496
42	12.092	15.488	18.400	20.177	21.812	22.020
43	12.381	15.858	18.838	20.658	22.333	22.545
44	12.667	16.224	19.274	21.135	22.849	23.066
45	12.954	16.592	19.710	21 614	23.367	23.589
46	13.240	16.959	20.146	22.092	23.884	24.110
47	13.530	17.330	20.587	22.575	24.406	24.637
48	13.817	17.698	21.024	23.055	24.925	25.161
49	14.104	18.065	21.461	23.534	25.442	25.683
50	14.392	18.434	21.898	24.013	25.961	26.207

Machinery

Shape of the Sprocket Teeth

From the foregoing it will be obvious that the life of the chain and the sprockets depends greatly on the proper designing of sprockets, both as to pitch diameter and shape of teeth. In Table 1, P = pitch of chain measured as a chord between two tooth centers; T = thickness of tooth along the pitch circle; A = distance from pitch circle to rim (this is frequently called "backing"); H = height of tooth above rim; and B = distance from pitch circle to base circle, the latter being the circle on which the centers are located for drawing the faces of the teeth to radius R.

The base circle is located inside the pitch circle in order that the chain may easily release itself from the tooth and seat itself properly as the tooth enters the chain. Radius R is made slightly less than the pitch of the chain after deducting the radius of the hook. Fillet radius F at the base of the tooth is slightly less than the radius of the chain hook, the difference allowing for slight imperfections in sprocket castings without interfering with the seating of the chain. Width W of the rim is less than the width of the openings in the chain by an amount that will allow for variations and irregularities in the castings and still permit free action of the chain. The sides of the teeth are curved to guide the chain to its proper place on the rim. These curves may be struck from a center located on the sidewise projection of the base circle, as indicated.

Thickness T of the teeth may be less than the value given in the table for sprockets having a large number of teeth, since the wear is distributed over a greater surface. Thinner teeth allow a greater elongation of the chain before detrimental action takes place. The reduction in the thickness may be 10 per cent for sprockets having from 16 to 25 teeth, and 20 per cent for sprockets of 26 and more teeth.

The amount of metal in the teeth may be reduced by means of "flutes" L in the rim. These flutes should not extend beyond the normal position of the side bars of the chain, and the base circle is a good limit for them. Besides reducing the weight of the sprocket slightly, a better quality of castings is produced, as there is a more uniform section of metal, which reduces the probability of shrinkage strains.

How to Run Sprocket Chains—Location of Tightener Sprockets

It has been proved by practice, and can be demonstrated theoretically, that chains give longer service and produce more satisfactory results as to wear on the sprocket teeth when run with the large or hook end of the link first. Some authorities advocate running the small end first on elevators and conveyors, claiming that since the head sprocket does practically all the work, there is a slight advantage as to wear on the head or driving sprocket when the chain is run with the small end first.

When it is necessary to use a tightener or idler sprocket, it should be placed on the slack or idle side of the chain whenever possible. It is usually placed on the outside of the chain, and when this is the case, its pitch diameter should be the same as that of a normal sprocket of an equal number of teeth, since the distance from the center of the hook to the open side of the chain is slightly less than to the closed side in contact with the driver and driven sprockets. When the tightener runs on the inside of the chain, its pitch diameter should be the same as a driven sprocket of an equal number of teeth. The bearing surface in the hub of tightener sprockets should be liberal, and ample provision should be made for lubrication.

Use of the Tables

The tables here presented need little explanation. Table 1 gives the dimensions of the teeth of sprocket wheels for chains commonly used. Table 2 gives the dimensions of steel detachable-link chains made by a leading manufacturer. Table 3 gives the normal pitch diameter of sprockets having from five to fifty teeth.

In designing a sprocket wheel for a given chain, the pitch diameter for the required number of teeth will be found in Table 3. If the sprocket is the driver, approximately 1/16 inch should be added to the normal pitch diameter, and if driven, 1/32 or 1/16 inch should be deducted. From the third column in Table 1, the distance A from the pitch circle to the rim is determined; this dimension is then doubled and deducted from the pitch diameter to obtain the rim diameter. To obtain the outside diameter of the sprocket, add to the rim diameter, twice the height of the teeth H. The base circle may now be located by laying off from the pitch circle the distance B given in the fourth column. The thickness of tooth T, face radius R, fillet radius F, width of rim W, etc., may each be found in the table as required in laying out the sprocket.

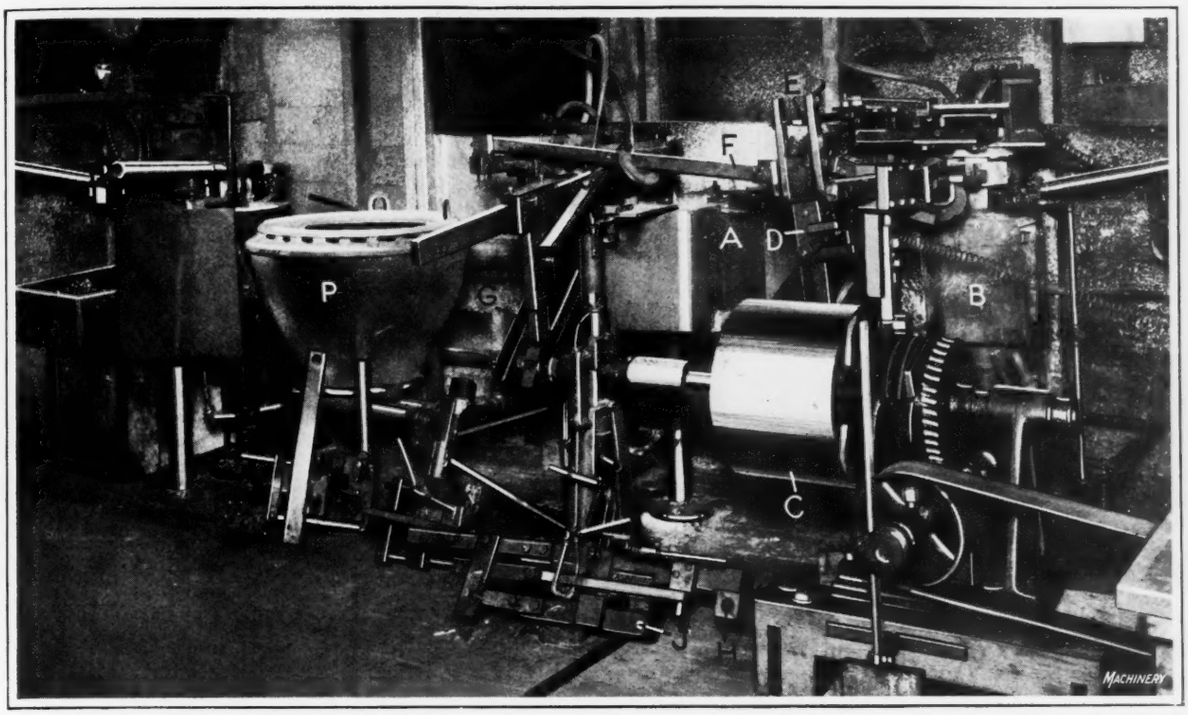


Fig. 1. Two Die-casting Machines each of which can be operated automatically through 1500 Cycles per Hour

Die-casting Lead- and Tin-base Alloys

Equipment Used and Methods Followed in Casting Soft Metals in Dies Under a Pressure of Only a Few Pounds

OPINIONS seem to differ among manufacturers of die-castings as to whether it is better to force the molten metal into the molds under a high air pressure or whether little or no pressure should be exerted on the metal. Most aluminum die-castings are produced with an air pressure ranging from 100 to 500 pounds per square inch, depending upon the type of casting, and in casting certain metals and kinds of parts, pressures up to 1500 pounds per square inch are used. It has been the experience of Robert E. Byrd, 318 Reed St., Erie, Pa., maker of die-castings, that parts made of pewter, Britannia metal, white metal, babbitt, etc., can be cast most satisfactorily without employing any air pressure and only a slight mechanical pressure. Mr. Byrd regularly builds two hand-operated machines for producing castings from these soft alloys, and has built automatic machines that have operated as rapidly as 1500 times per hour. In this article the operating principles of these machines and some applications of the process will be explained.

Construction of the Machines

The larger machine, which may be used to cast parts up to about 5 1/2 pounds in weight, is shown in Fig. 2. Within the sheet-steel housing *A* is a substantial iron casting which is mounted on a pedestal extending to the floor. This casting is hollowed out on the upper side, and in the depression, the metal to be cast is melted by the heat from gas flames that play against the bottom of the pot. About 90 pounds of metal can be melted in the pot at one time. Directly above the pot is a plate to which two guide rods are attached; on these rods a die-bolster may be slid up and down by operating handle *B*. Die-plates *C* and *D* are attached to the bolster, which is hinged so that it may be swung open in order to remove the work after the operation.

In the front of the melting pot is a vertical cylinder in which a piston is lowered by means of handle *E* to force metal up through an opening in plate *F* and into the dies. The dies have an opening in the under side directly over the hole in the plate, so that when the dies are lowered on plate *F*, the metal is forced into all the impressions in the dies, where it solidifies.

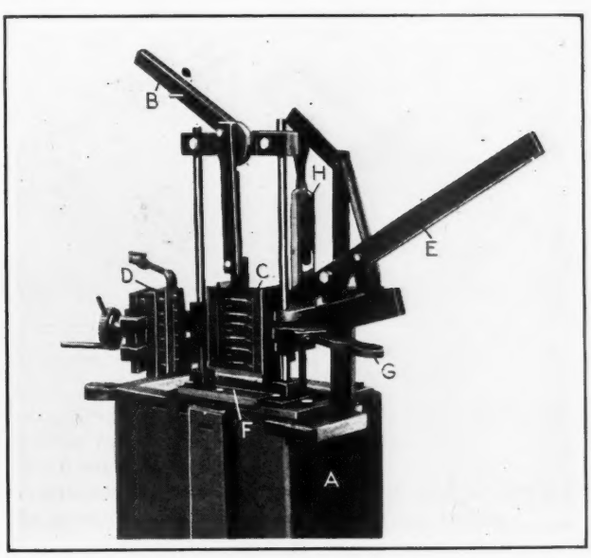


Fig. 2. Hand-operated Die-casting Machine which may be used to produce Parts weighing up to 5½ Pounds

In operation, die *D* is locked to die *C* by means of handle *G*, which engages a round bar on the swinging half of the bolster. The dies illustrated are used for casting six small parts at one time, and die *D* is provided with vents that permit the escape of air from all impressions in the other die as the metal enters. The dies are cooled by hot or cold water so that as soon as lever *E* is raised again, the work will have solidified and the bolster can be swung open to eject the work. A thermometer *H* is hung from a bracket with the lower end extending into the melting pot, in order to keep a close

check on the temperature of the metal. Both solid and hollow, or "slush," castings can be produced with this machine, the production depending upon the type of casting, whether a number of cores must be pulled, and whether two or more pieces can be cast at one time. Production figures for a variety of parts will be given later. This machine weighs about 225 pounds.

The second "miniature" hand-operated machine, which was illustrated on page 156 of October, 1924, MACHINERY, consists essentially of a melting pot 6 inches in diameter, a small cylinder and piston, and a piston-operating mechanism. The pot holds about 15 pounds of molten metal. The piston is of a half ball shape on top, and the dies are made with a recess to fit this seat. The dies are made up of two blocks, which are clamped on the piston for the operation. When the piston and dies descend as a lever is depressed, the metal is forced into the dies until the cavity is full. In this case, the dies are attached to a hinged member that permits them to be readily swung apart and together. This holder is equipped with a wooden handle so that the dies can be placed on the piston and removed by hand. Small toys, souvenirs, emblems, and an endless variety of small parts can be produced with this equipment. It may be operated up to 100 times per hour for producing up to 500 castings per hour.

Fig. 3. Small Sun Glass with a Retaining Band and Handle cast around it

Advantages Claimed for the Process

From the preceding description it will be obvious that the pressure used to force the metal into the dies amounts to but a few pounds, and because the pressure is entirely mechanical, no air is admitted with the metal. Also because the metal enters the dies under a slight pressure, all air previously in the die impressions is forced through the vents so that the dies are completely filled. As a result, solid castings, free from air holes and with sharp corners where desired, are produced.

It is pointed out that air pockets are common in die-castings simply because the metal is forced into the dies under too great an air pressure, so that when the metal strikes a core or any projection in the die cavity, it forms a small whirlpool on the far side which results in an air pocket, instead of completely surrounding it. There is an analogy in the manner in which the water of a swift stream passes a projecting rock. As the water strikes the rock, it divides, passes on each side and meets a certain distance from the far side of the rock, with the result that a V-shaped opening of air exists there. If the water flowed slowly around the rock, no such air space would be formed.

Smooth castings are obtained with this process by keeping the metal at comparatively low temperatures, maintaining the dies at a temperature only slightly lower than that of the molten metal, and applying a "Die-Kote" solution to the die cavities at intervals to cause the metal to adhere to them. The molten metal is kept at a temperature of from 450 to 900 degrees F., depending upon the mixture and the nature of the casting. When the opening in the dies through which the metal enters is comparatively large, so that it can be readily forced through, the metal need not be so hot as when the opening is small. Also, when there are many recesses and cores in the dies, the metal must be hotter than when the casting is a simple one.

Dies used on the large machine are cooled by circulating either hot or cold water through openings, cored or machined around the gate. In the case of the small machine, the dies can be kept sufficiently cool by simply immersing one end quickly into water after each operation. The "Die-Kote" solution is made by mixing about one pound of a red powder in a bucket of water, this amount being sufficient to last many weeks. The solution is not a cleanser, but seems to have an affinity for the casting metal that causes the metal to hug the die surfaces. Its use has eliminated spotted surfaces, wrinkles, and depressions in the castings. When the solution is applied, which is necessary about once every three hours, the dies must be hot enough to sizzle.

"Slush" castings are produced by forcing the metal into the die cavity and then quickly raising the piston to allow some of the metal to run back into the cylinder. In the meantime, the water-cooled dies will have chilled the metal directly in contact with them so as to form a wall, the thickness of which depends upon the temperature of the dies and of the metal.

This process has several outstanding advantages over producing castings by hand-pouring. When poured by hand, the mold and metal usually become so hot as to leave large fins on the casting, which take more time to trim off than is required for both casting and trimming parts produced by the method described. Hence, production rates are much higher with this process. Also, when the metal runs into the mold by gravity, the mold is not always filled completely nor as solidly as when a slight pressure is applied.

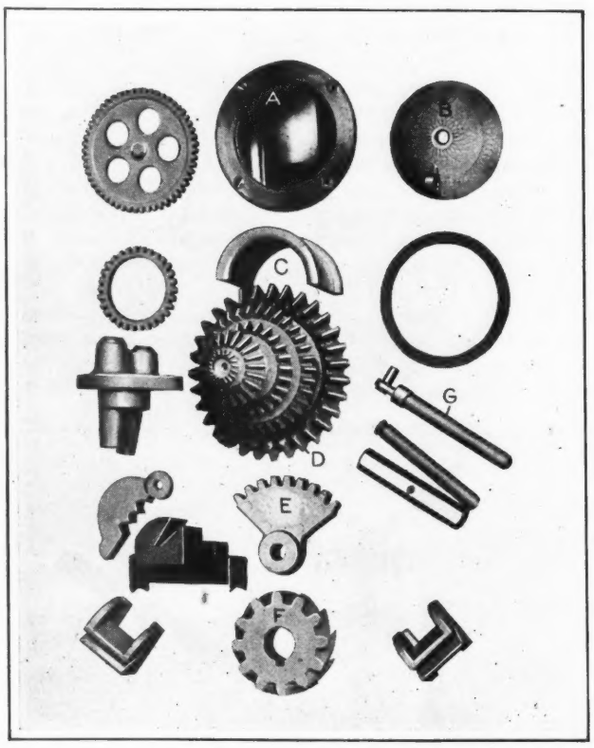


Fig. 4. Illustration showing Large Variety of Parts that can be readily made by the Die-casting Process

Typical Examples and Production Figures

Parts of almost endless variety can be produced by this method, as will be apparent from Fig. 4, by using cores, inserts, etc., which can be conveniently withdrawn. The gears illustrated are employed in mechanisms where no great stress is placed upon the teeth. In many cases castings made from tin- and lead-base alloys, which may have a quantity of antimony or copper added to increase the strength, may be substituted satisfactorily for castings made from brass, aluminum, and zinc. Castings made from the latter metals are often used in cases where their strength is unnecessary, several examples being the handles of automobile doors, casket hardware, etc. Pieces such as these are nickel-plated anyway, so that the question of appearance is not involved.

Example *A*, Fig. 4, is an unusual one; it consists of a ring with four countersunk-head screws in it, cast around a mirror. At *B* is illustrated the back of a mirror which has a lug on it for attaching a handle. This part is about 2 1/4 inches in diameter, and when two pieces are cast at one time in a mold, the production is about 200 pieces per hour in the big machine. At *C* is shown a half bearing made of a high tin-base metal at the rate of about 250 castings per hour, using dies in which two pieces are produced at one time.

A stack of bevel gears which are produced separately is shown at *D*, and at *E* is a small segment gear. Using dies in which one part is cast at a time, about 200 segment gear castings can be produced per hour in the big machine, and by casting two at a time, the production can be doubled. About 100 segments can be produced per hour with the small machine, casting one piece at a time.

An especially interesting example is the helical gear illustrated at *F* which can be cast at the rate of about 100 pieces per hour. At *G* is a steel handle to which a tip is die-cast, the handle being inserted in the die for the operation. Fig. 3 shows a sun glass around which a retaining band of metal and a handle are cast. The clean-cut letters and sharp corners produced by this process are clearly illustrated by this example. A high-school boy, after school, casts these glasses at the rate of three gross per hour.

An application of the process in which great economies have been effected is the production of magnets for pipe organs, from 600 to 700 of these magnets being generally used in one organ. Formerly the manufacturer paid 4 cents each for these magnets, and including shipping, inspection, and certain other charges, the cost was actually between 11 and 12 cents apiece. Many of these magnets were rejected after assembly, because of internal air pockets which could not be detected beforehand. To eliminate these difficulties, the manufacturer commenced die-casting the magnets by means of the process here described. He produces them at the rate of 500 per hour with scarcely any defective ones, so that the cost per magnet now averages only about 2 1/2 cents.

Many parts that are later silver-plated can be satisfactorily cast by this method, including the spouts of teapots, salt and pepper shakers, etc. Even the hammered effect used to a great extent in tableware of this kind can be obtained without difficulty.

The dies are made from cast iron or machine steel when the part must be produced to certain dimensions within close limits, but when parts are more of an ornamental nature and need not be especially accurate, the dies may be made from brass. In making a brass die, a plaster-of-paris pattern is first made from a model, and then a sand mold is made from this pattern, in which the die is cast. This casting can generally be used after cleaning up slightly with files, scrapers, etc. The cores are mostly made from tool steel, hardened and lapped to a mirror finish so that they will slip in and out of place readily.

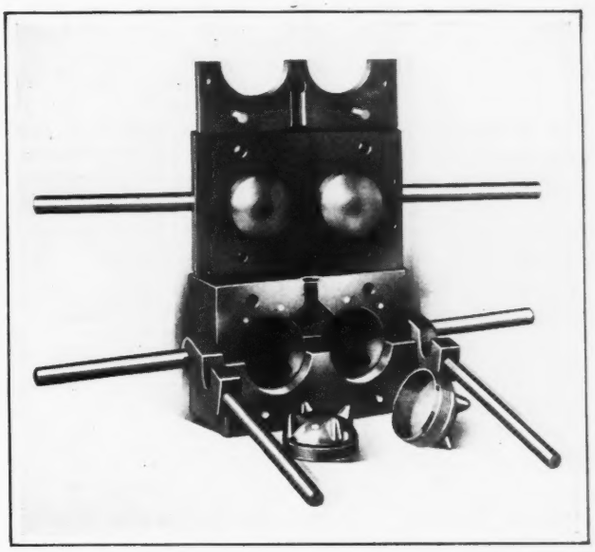


Fig. 7. Dies used on the Small Die-casting Machine for casting Radiator Caps for Automobiles

Threads can easily be produced on parts, as may be seen from Fig. 5, which shows the die equipment used in casting two tops for salt and pepper shakers. The same equipment is shown in Fig. 6 with the bolster closed. This equipment is more elaborate than is necessary in most cases, because the cores must be screwed into place for the operation, and unscrewed before the castings can be taken from the dies.

These cores, which are shown at *A*, are made up of a machine-steel piece and a tool-steel center. The threads are cut on the machine-steel piece which is revolved and moved longitudinally when handwheel *B* is revolved. The central tool-steel piece has thirteen small pins in it that produce the holes in the shaker tops. These tool-steel cores, with their pins, are moved longitudinally by means of handle *C*, but do not revolve. They are withdrawn with the threaded portion of the core. Two cold-rolled steel pins *D* in the center of the die cavities are slid forward as the dies are opened, to eject the castings. It will be observed that the metal is forced through grooves *E* when the die is closed and lowered on the machine, as previously explained.

A die used in producing radiator caps for Ford automobiles is shown in Fig. 7 with two examples of the work. These parts are cast with eighteen threads per inch so clean that they need not be chased before using. In this case, the threads are formed by two split die-blocks, which are removed with the work and simply replaced in the dies by hand for the next operation. This die equipment is used on the small machine by simply setting it over the piston, as mentioned at the beginning of this article. While the production is satisfactory, a greater output

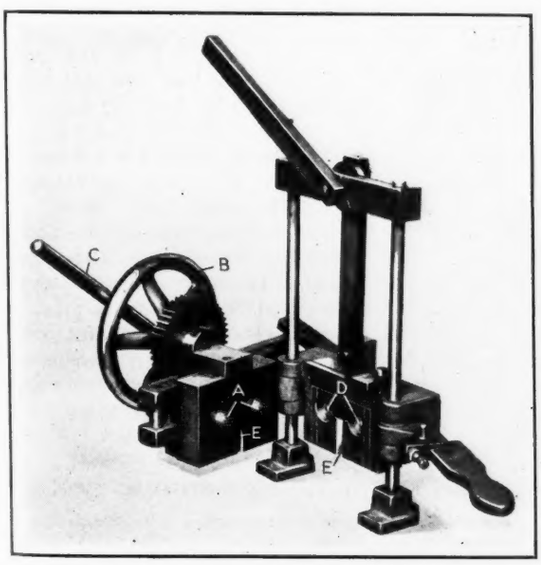


Fig. 5. Die Equipment used for casting the Threaded and Perforated Tops of Salt and Pepper Shakers

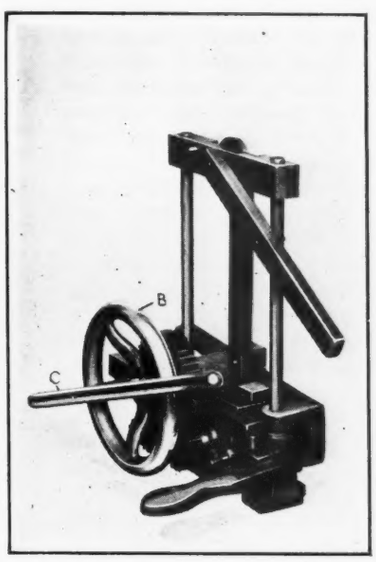


Fig. 6. Equipment shown in Fig. 5 Closed, Ready for Use

could be obtained with the large machine. Intricate parts sometimes require dies with cores that must be pulled out from more than one side. The manufacturer points out that the dies last indefinitely, and in most cases are easily made, which, in combination with an inexpensive equipment, brings down the cost of the castings.

An Automatic Equipment

Two machines operated entirely automatically, with the exception of filling the metal pots about every half hour, are shown at the right in Fig. 1. Each of these machines has been operated 1500 times per hour, giving a production of 3000 pieces per hour, when the dies were designed for casting only one piece at a time. The metal is melted in the large pot *P*, and then transferred to the smaller pots of the two machines, which are surrounded by housings *A* and *B*, respectively. In the operation of these machines, the dies are swung horizontally to the left over a chute, where they are opened for ejecting the work, and then they are returned to the right for forcing metal into the dies in the next operation.

Pulley *C* is driven at 1440 revolutions per minute by a 1/2-horsepower motor, which drives through a belt and worm-gearing. This pulley has cams on its periphery that rock bar *D* back and forth, causing rod *E* on the right-hand machine to swing the dies back and forth, as mentioned. The inserting and withdrawing of the cores, the opening and closing of the dies, and the ejection of the casting are all performed automatically. Similar movements are imparted to the left-hand machine through rod *F*. At *G* may be seen the discharging chute of this machine. A complete die mechanism is shown lying on the floor. The entire mechanism pivots around hole *H*, while the die proper is hinged at *J*. When the photograph was taken, the machine at the left produced a hollow (slush) casting, while the one at the right made a solid casting from which a core was pulled from each end and from one side.

* * *

A PARADOX IN POWER DEVELOPMENT

In a recent number of the *Sibley Journal of Engineering*, Irving P. Church, professor emeritus of applied mechanics and hydraulics at Cornell University, states that a vehicle may be moved directly against the wind by means of a wind wheel actuated by the same wind. When confronted by this statement, a number of scientists and engineers have said positively that such a vehicle is a mechanical paradox and that it will not work. Professor Church states, however, that he has actually constructed a model of such a device and that it does work. Professor Church's wind-locomotive does not tack like a sail boat, but moves square into the breeze. The original model of the wind-locomotive is now in the museum of the College of Civil Engineering of Cornell University. The model is about 15 inches long, supported by three wheels—an undriven wheel in the rear, and two wheels in front driven by round belts from the shaft on which the wings of the wind motor are mounted. It is claimed that this model will make steady progress against the wind, regardless of opinions to the contrary. Professor Church demonstrates mathematically in the article referred to why this is possible, the demonstration being quite elaborate.

A wind-locomotive, or similar apparatus designed to work on the same principle, either on land or water, has frequently been proposed, and many inventors have endeavored to perfect practical devices, chiefly in the form of sea-going ships which could be driven straight against the wind by the wind's own force. None of them has, as yet, proved a practical success, nor does Professor Church intimate that his wind-locomotive is destined to replace other forms of prime movers; but the experiments are certainly of unusual interest from a purely applied-science point of view, and they constitute another example of how scientific research overcomes obstacles and accomplishes the seemingly impossible.

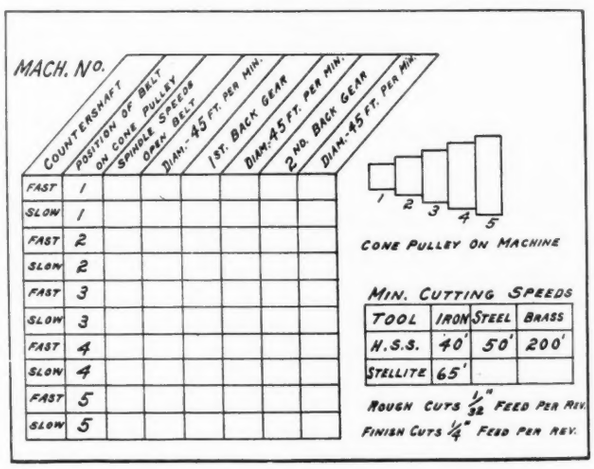
CHART FOR DETERMINING LATHE CUTTING SPEEDS

By BRUCE DEVEREAUX

In the accompanying illustration, is shown a form of chart to be used with lathes in order to enable the operator to determine quickly a suitable trial speed for every new job. The correct spindle speeds for the columns headed "Spindle Speeds for Open Belt," "First Back Gear" and "Second Back Gear," must, of course, be calculated for each machine. The diameter of work corresponding to a surface speed of 45 feet per minute for each of these spindle speeds is also calculated and filled in.

By making use of charts like the one shown, in connection with the tables found in the revised edition of MACHINERY'S HANDBOOK on page 864, the workman can determine quickly on which step of the cone pulley he should place the belt, and whether he should use an open belt or throw in the first or second back-gear to obtain a given surface speed.

For estimating time on new work and for checking speeds on old work, the writer has used a simple device or table similar to that found in MACHINERY'S HANDBOOK on the page previously referred to. The device consists of a piece of cardboard, about 5 inches long and 2 inches wide, on which



Form of Chart used in determining Trial Cutting Speeds on Lathe

is copied that part of the table found in the HANDBOOK which is needed to cover the range of cutting speeds required.

One of these devices used by the writer covers a range of diameters varying by increments of 1/16 inch from 1/4 inch to 2 inches, and the corresponding speeds for 40, 45, 50, 55, 60, 65, and 70 surface feet per minute. Instead of placing the figures, 40, 45, etc., above their respective columns, they were placed on a cardboard slide or collar, which is slipped over the piece of cardboard on which the table is printed. This slide can be run up or down on the cardboard until directly over the horizontal column bearing the required diameter of work in the column at the left-hand side and the corresponding spindle speeds at the right.

* * *

AMERICAN FOUNDRYMEN'S CONVENTION

The American Foundrymen's Association, 140 S. Dearborn St., Chicago, Ill., will hold its annual convention this year at Syracuse, N. Y., October 5 to 9. In connection with the convention there will be a foundry and machine exhibit in the buildings of the New York State Fair Grounds, which are exceptionally well adapted for such a purpose. The total exhibit space available is larger than any that has been at the disposal of the association in the last five years. The fair grounds where the exhibit will be held are located four miles from the center of Syracuse, but good transportation service will be available. An extensive technical program is also arranged for the convention.

Bending Steel Structural Members

By C. C. HERMANN

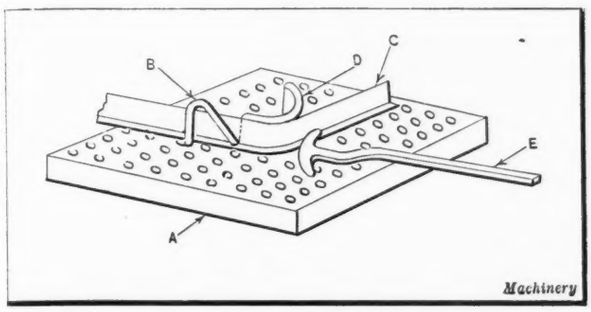


Fig. 1. Floor Plate for bending Structural Members

IN the article "Machine Forging and Bending Dies," published in May MACHINERY, the fundamental principles governing bending operations in dies of the forging type were dealt with, and some simple designs of bending dies were illustrated and described. The present article will describe the bending of structural sections, and some special bending work where the small number of pieces required does not make it profitable to construct bending dies. In almost every industry employing structural steel, there are cases where only a few formed members of a certain type are required. To employ dies in such instances would be out of the question. On the other hand, the production of even a limited number of formed pieces by hand smith methods is also expensive. Hand methods are often resorted to, however, in bending structural steel when but a few pieces are required, as, for example, in bridge building.

Bending Work on Floor Plate

The usual method of bending large structural angles, channels, T-sections, and I-beams is illustrated in Fig. 1. The floor plate *A*, which may be of any suitable size, is provided with numerous holes in which clamps and dogs may be placed for holding the work and the pattern to which the piece is to be formed. The dog *B* is used to hold the work on the plate. In this case a right-angle bend is to be made in the 3- by 2- by 1/4-inch angle-iron *C*. This piece is used as the frame of an industrial truck, a number of which were built under the writer's direction. The form *D* is first clamped to the surface of plate *A*, after which the heated work is clamped against the form in such a position that the bend will be made at the desired point. The bending lever *E* is provided with a pin on its under side that fits the holes in plate *A*. This lever is used in bending the free end of the work against form *D*.

Bending Channel Members

The bent channel member shown at *A*, Fig. 4, serves as the front yoke of a vehicle, and is formed from a standard 3-inch structural steel channel. The legs of the channel face outward, leaving the flat side on the inside of the bent member. As these members are used in large numbers, quantity production methods must be employed. In addition to this requirement, the parts must be made interchangeable; that is, each piece must be an exact duplicate of the model yoke. Two bending operations are required to form this piece to the desired shape. The 9-degree bends, as shown at *B*, are made first, after which the ends are bent up at an angle of 90 degrees, one end being bent at a time.

Bending Die for Channel Member

The die used to make the 9-degree bends in the channel member is shown in Fig. 2. This die is designed for use on a bulldozer, *A* being the base block and *B* the ram block. As the work is bent hot, the angle of the die face is made the same as that on the finished work. The base block is cast from a pattern constructed with heavy ribs. The section of the pattern having the deepest draw is placed in the drag mold, and the face *C* is given sufficient draft to insure a smooth casting at this point, which must be machined to receive the working face *D*. Face *D* is made of 0.80 to 0.90 per cent water-hardening carbon steel, and is secured to the base block with flat-head machine screws.

The bottom part of the casting for the die which is molded in the cope flask is often found to be softer than the part molded in the drag, and for this reason an extra allowance in the thickness of the metal must be made to insure a solid, smoothly finished surface. The groove *E*, indicated by the dotted line in the side view Fig. 2, is machined to fit the ways of the bulldozer, and serves to hold the base block parallel with the ram of the machine. The surface between the ways, however, is not machined. The base block is provided with ram block guides *G*, the corners of which are beveled or cut off to an angle of 45 degrees in order to facilitate the entrance of the ram block on the forward stroke.

The ram block *B* is a plain casting, machined as indicated by the finish marks. The working face is cast with the necessary draft to permit easy drawing of the pattern from the sand, but this draft is removed when the face is machined. The guide blocks of the base are machined along the sides to a sliding fit on the base block. As the legs of

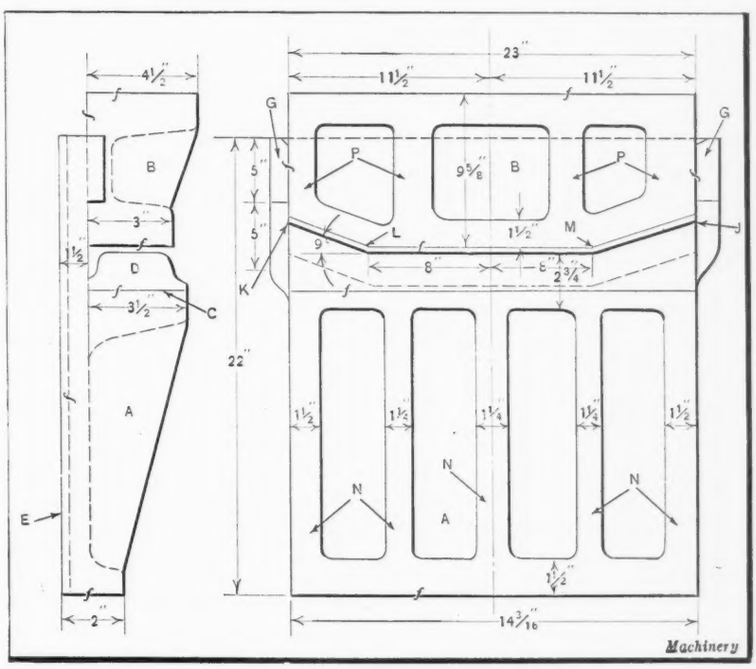


Fig. 2. Die used to bend Channel to Shape shown at B, Fig. 4

the channel member fit over the steel face of the base block, the ram block may be left square. The bottom of the ram block is recessed to a depth of about 1/8 inch, except at the bearing points, in order to eliminate the necessity for finishing the entire bottom surface.

The steel face *D* of the base block is made in three sections, the joints coming at the intersections of the three straight faces. These steel sections are machined to an accurate fit for the inside of the channel member, and are secured to the base block by machine screws. The channel to be bent is placed across the die in contact with the points *J* and *K*, with the sides of the channel pressed into the recess of the face section. The channel member is heated at the bending points in a forge for the bending operation. When the ram advances, it strikes the work between the points *L* and *M*, forcing it inward against the base block.

The stresses to which dies used in bulldozers are subjected should be carefully considered, and the metal in the dies distributed in such a manner as to resist these stresses. As a rule, it is best to connect two or more high points on the die with metal ribs instead of making the die solid. It should be borne in mind that the ultimate compressive strength of gray or cast iron is approximately 90,000 pounds per square inch and that the metal in the die may be stressed to the limit set by a safety factor of 10. The method of employing ribs to strengthen the casting is shown in Fig. 2, the ribs on the base block being designated by the reference letter *N* and those on the ram block by the letter *P*. The recesses between the ribs must be of such shape and size as will permit the pattern to be easily drawn from the drag mold without danger of injuring the mold or making the projecting portion of the mold too frail to stand up under the action of the molten metal when the mold is poured.

Die for Second Bending Operation

After the work has been bent to the shape shown at *B*, Fig. 4, the ends are bent to the upright position indicated at *A*, one end at a time, in the die shown in Fig. 3. Both ends of the work could, of course, be bent at one stroke if a bulldozer of sufficient size were available. If this were done, however, it would probably be desirable to use a wing type of die.

In bending one end at a time in the die shown in Fig. 3, the work is located by means of the pin *C*, which fits a hole in the work. In addition to being held in the required position by pin *C*, the work is pressed tightly against the face of the die by an eccentrically pivoted clamp *F* provided with a hand operating lever. If the clamp were not used, the work would pivot about the corner *G* of the base block until the corner *H* of the ram block made contact with it, in which case the bends would not be uniform or duplicates of the original pattern.

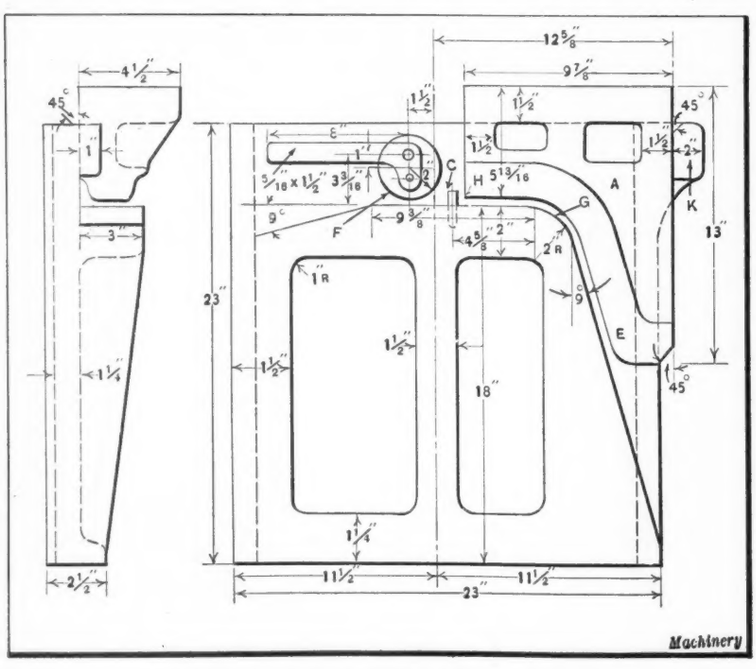


Fig. 3. Die for bending Ends of Channel Member

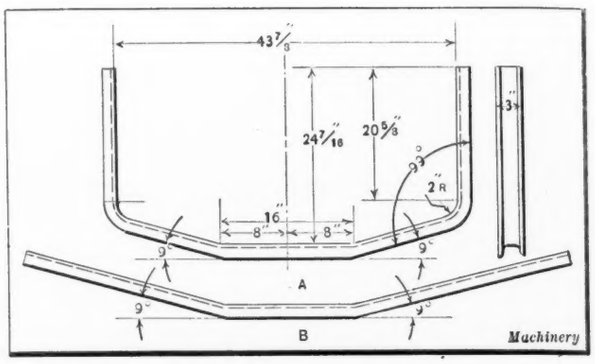


Fig. 4. Channel Member formed in Bending Die

Operation of Bending Die

As the ram block *A* moves forward, the end *E* comes in contact with the work and continued movement bends the end around the corner *G* of the base block. In this operation, considerable side pressure is exerted on the ram which has a tendency to force it to the right. This side pressure would cause the shape or form of the bend to vary if it were not counteracted by the projecting bearing surface at *K*. This surface acts as a guide for the ram, in addition to relieving the machine of the side strain. The ram block is machined to fit the channel, and must seat properly against the work and base block at the end of the stroke.

After one upright is bent, the other end of the work is heated in a furnace, and bent in the same die. In bending structural members, it is better to have the stretching action confined to the sides or legs of the section rather than to the web. When the leg portions of the member are compressed and the web stretched, crimping is likely to occur in the metal of the leg sections. When it is necessary to compress the leg sections in making a bend, it is advisable to design the bending die with a groove just deep and wide enough to receive the leg section, in order to prevent the crimping or buckling of the metal as far as possible.

Considerable care must be taken in rounding the end *E* of the ram die, in order to avoid bulging the web of the channel. If this end is too sharp, it will have a dragging action on the metal that will cause a bulge in the web where the ram first comes in contact with the work. To avoid this, the point should be rounded to a radius that will allow it to slide readily along the work as the bending action proceeds. The end *E* of the die should be as long as it is practical to make it, in order to prevent kinks from being formed in the straight portion of the work that projects beyond this member.

Forming Car Roof Members on Bulldozer

In Fig. 5 is shown a bulldozer equipped with dies for bending or forming steel roof members for railway cars. Two of the roof members are shown standing against the end of the die. The entire forming operation on one of these members is performed at a single stroke of the machine. The members are formed from 10-gage soft steel, which flows readily when cold and subjected to great pressures. As the blank is drawn an equal amount on both sides, it must be

properly centered on the die before the ram of the machine advances to perform the bending operation. To meet this requirement, the face of the base block is raised somewhat above the table, so that the stock or blank may be placed across the face of the die with its center line coinciding with that of the die. The face of the die is made of steel, and is secured by ordinary means to cast-iron blocks.

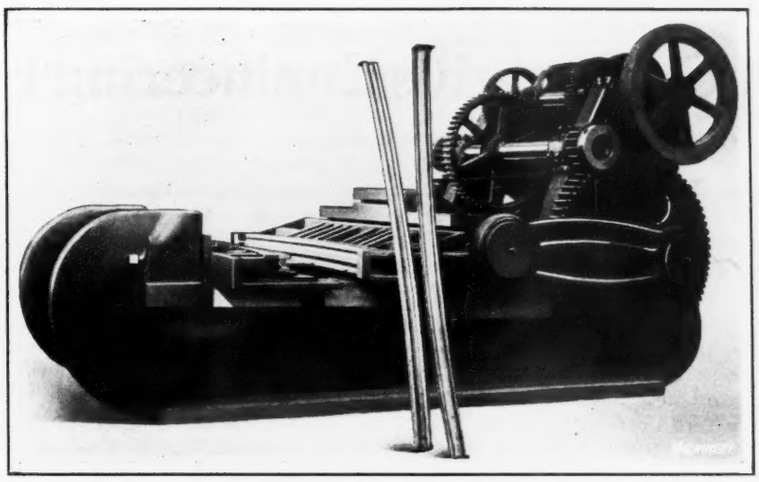


Fig. 5. Bulldozer equipped for forming Car Roof Member

The temperature to which structural steel is heated for forging determines to a considerable extent its ultimate strength. If the steel is heated above the recalescence point, which is 1250 degrees F., it should be allowed to cool slowly and then be heated again to a temperature just above 1250 degrees F. and allowed to cool without quenching. This treatment of structural steels relieves the internal stress, restores the fine texture of the steel, and results in the production of members having the greatest possible strength.

Hand-operated Bending Device

Many of the bending operations required in experimental work can best be performed with a hand-operated bending device. Two types of hand-bending devices are shown in Figs. 6 and 7. A properly designed device of the type shown in Fig. 6 can be used for bending eyes, rings, and hoops from round, flat, or structural steel of any shape. If intended for light work, a device of this kind can be mounted on an ordinary work-bench.

The work is held between the forming pin *A* and the gripping dog *B*. The outer end is located by the gage-block *C*, which can be adjusted by means of the holder *D*. A guiding die *E* is provided to hold the work against the forming die *A* during the drawing operation. The gripping portion of the device is rotated by means of the lever *F*. A stop *G* is employed to limit the rotation of the gripping dies and thus determine the degree to which the work is bent. The gripping dog *B* can be adjusted to accommodate stock of various sizes, and the guiding die *E* is also made adjustable for the same purpose. In bending angles or any of the structural shapes, it is necessary to change the gripping dog and the back dies to conform with the shape of the work.

The hand bending die shown in Fig. 7 is intended primarily for forming pieces that are to be bent to some circular form at each end. The arms *A* are pivoted at *B*, and are provided with rollers *C* which are guided by grooves *D* in the table. Pins *B* are also provided with rollers *E*. The work to be bent is placed between the rollers *C* and *E*. The stop or gage *F* may be used to locate the work for duplicate operations. Levers *A* are shown in the position occupied at the end of the bending operation.

Hot and Cold Bending

Hot material can be bent to a much shorter radius than cold material; for example, when bending flat material on edge, the radius of the bend should be equal to the width of the material when bent cold, and one half the width of the material when bent hot, the radius being taken as the distance from the center of the bend to the edge nearest the center. Thus bends that are 1 1/4 inches wide can be bent edgewise, when cold, to a radius of 1 1/4 inches, while the same material, when heated, can be bent to a radius of 5/8 inch. Sharper bends than these should not be made on a bending machine. It is not possible, of course, to make as sharp bends in angle-iron as in flat or bar stock.

For bending angle-iron hot, the minimum bend should have a radius equal to the width of the web, the radius, in this case, being taken as the distance from the center of the bend to the nearest edge of the web. For cold-bending the radius should be twice as great. The minimum radius for bending pipe taken from the center of the pipe to the center of the circle is 1 3/4 inches for 1/2-inch pipe, 2 3/4 inches for 3/4-inch pipe, and 3 1/2 inches for 1-inch pipe. The writer has made very satisfactory bends corresponding to these radii when the pipe was filled with sand for bending.

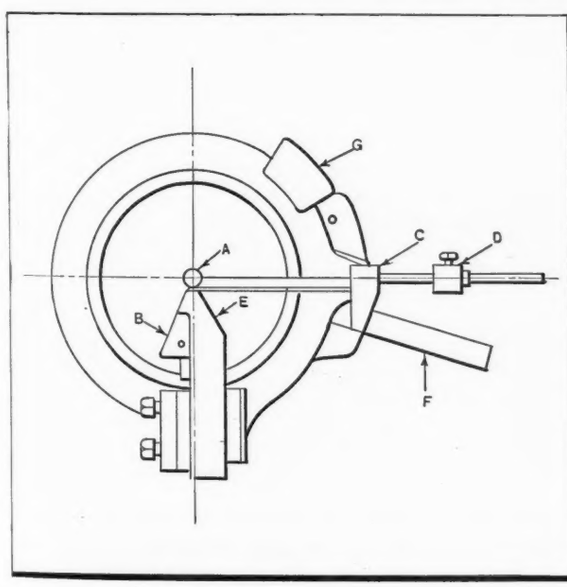


Fig. 6. Hand-operated Bending Device

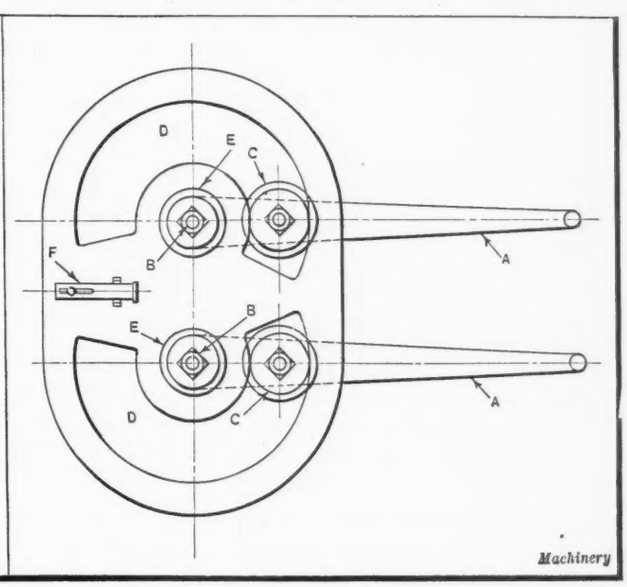


Fig. 7. Double-end Hand-bending Device

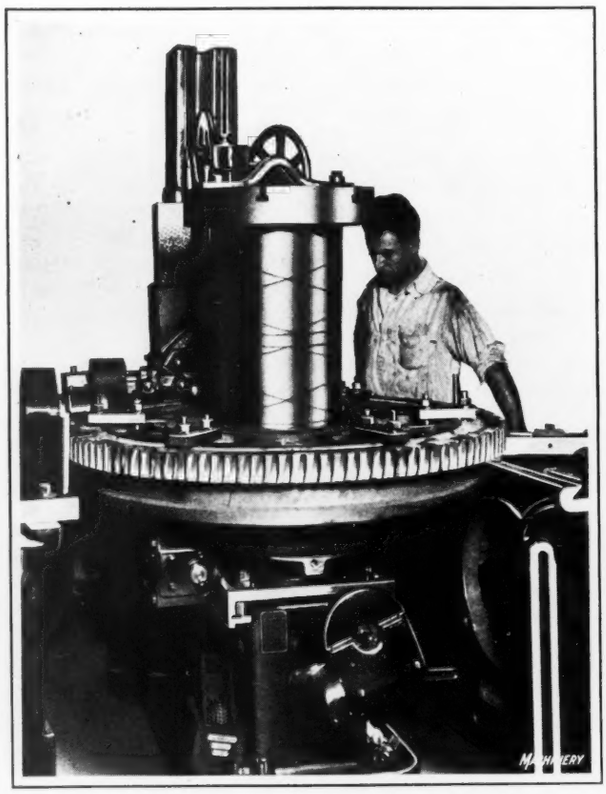
Spread of Cooperative Engineering Education

By ALLAN R. CULLIMORE, Director, College of Engineering of Newark Technical School, Newark, N. J.

THE cooperative method of educating engineering students is based upon such sound principles that there is little wonder that the plan has spread widely in the twenty years that have passed since its inauguration at the University of Cincinnati by Dean Herman Schneider. Among the many institutions that have adopted this plan are the University of Akron, Harvard University, Massachusetts Institute of Technology, New York University, and the Newark Technical School. The characteristics of the plan and how it is carried out at the last-named of these colleges are explained in the following:

Preparation for a Life Work

By the cooperative method, engineering students receive practical experience in industrial plants at the same time that they are taught theory in college. This is accomplished by having the students spend alternate periods in the school room and in the shops of concerns cooperating with the school. As a general rule, the cooperating concerns choose students with the intention of absorbing them permanently in their organizations when they have graduated. By this method employers can learn the worth of the students and train them economically to fill specific positions; and it does not involve the losses of time and money often experienced by large companies who hire engineers graduated from universities that are not run on this plan.



Engineering Student doing Practical Work in a Machine Shop

The fundamental advantage of the cooperative method is that the student commences real work while he is still under the guidance of the school authorities. Hence any errors at the beginning of his professional life, can be rectified before results occur that might be disastrous to his career. When the student graduates, he knows quite definitely about the various practical things in his profession. It must be borne in mind that the cooperative plan is not to make a skilled mechanic out of the youth; he is learning to be an engineer, and his shop experience is intended solely to give a practical background to his theoretical training. What does it matter if the student is assigned occasionally to laborious jobs such as shoveling sand in the foundry? He is doing practical work!

The purpose of the cooperative plan cannot be better explained than by the following abstract from a catalogue of Harvard University: "The object of the practical training is primarily to place students in personal contact with the problems of industry. The students naturally become familiar with the tools and machinery of production, and may acquire considerable skill; but this is of secondary importance. The work is intended to enlarge the students' experience: to broaden their vision; to increase their understanding of, and sympathy with, the problems of labor; to teach them something of the practical side of industrial problems, both technical and executive, and of the limitations which practice imposes on theory; and to stimulate their interest in classroom instruction. The plan provides an opportunity for students to begin their adjustment to practical conditions under favorable circumstances at a formative period in their career, and at an age when the shop men are likely to look upon them as fellow-workers."

How the Program is Carried Out

Boys must have a high school or equivalent education in order to matriculate at the College of Engineering of the Newark Technical School. Mechanical, electrical, and chemical engineering are taught at this college. During the summer vacation preceding his freshman year and the summer intervening between his freshman and sophomore years, the boy is expected to work at any occupation he may select, but preferably at some job connected with the profession he has chosen. If necessary, the school authorities assist him in securing a position. The cooperative period between the school and shop does not commence until the student has completed his freshman and sophomore years. In the school, these first two years are spent as they would be in any college, the entire time being devoted to lectures, recitations, and laboratory work.

At the end of the sophomore year the boys are paired for alternate attendance at school and at some particular shop. When one boy of the pair is in the school, his alternate is in the industry. The period of alternation may be two or four weeks. With this arrangement each boy during his junior and senior years is in the school one half of the time and in the industry the other half. Including the two summer vacations prior to their sophomore year, the boys spend two entire years in shops during their college courses. In order that the theoretical education of the boys may be on a par with the education given in the ordinary university, the courses are made quite difficult. The work in the industry is primarily for educational purposes, but in all cases the boys receive compensation for their work. In starting each boy in an industrial plant, he is made to realize that he must "make good" in practical work before he can receive his degree.

The Work of the Cooperative Supervisor

During the period that the boys are in the industrial field, their work is supervised by a representative of the school

who serves as a contact point between the school and the cooperating concern. This supervisor personally visits the boys some time during each one of their periods in the shop in order to advise them on the way in which they should conduct themselves and on other matters, and also to learn how the boys suit their employers. The supervisor is responsible for all relations between the college and the industrial plants.

After each visit to a boy in the shop, the supervisor makes out a report outlining the boy's work during that specific period, and giving any comments of the employer or student, the number of days the student has been absent from his work, and the reasons for the absences, as well as any other pertinent information. At the end of each period, the employer also makes out a report in which are given the number of times that the student has been absent or late and ratings on the following characteristics: Initiative, mechanical ability, attitude toward work, obedience, attitude toward receiving instruction, and tact.

There is seldom any difficulty in getting students started correctly in the shop, as they are placed there early in their college careers when they realize that they do not know any too much about their profession. Hence they are not likely to put on airs, and by so doing lose the respect of the shop men, as sometimes happens when a young man does not enter industrial life until after he has earned his degree. The work assigned to the student depends in each case upon the individual plant and boy.

Coordination of the School and Shop Training

In order to have the shop work of the students proceed smoothly, it has been deemed advisable that all dealings between the faculty and the shop should be carried out through a "coordinator." Another function of the coordinator is to conduct a class in which questions are discussed informally that arise in the minds of the students from their shop experiences or otherwise and that cannot be properly brought up in any of the classrooms. Four hours a week are devoted to this class, which is attended only by boys in the junior and senior years.

In most sessions of this class some person of prominence or ability connected with an industrial plant speaks on a given topic, and at the end of the talk, the students ask any questions relating to the subject that may come to their minds. The subjects chosen deal with financial matters, employment problems, patent laws, psychology of handling men, etc.

The Gould & Eberhardt Co. led the way in developing the cooperative system of education for this school, and at the present time has six students working in the shop on this plan. The accompanying illustration shows a student in the Gould & Eberhardt shop engaged in cutting the teeth of a large worm-gear. Other concerns in the vicinity of Newark with whom cooperative relations have been established include the General Electric Co., the Newark Gear Cutting Machine Co., Singer Mfg. Co., National Lock Washer Co., Weston Electric Instrument Co., Crocker-Wheeler Co., Public Service Electric Co., Chemical Co. of America and Proctor & Gamble Co. The success that this school has had in carrying out cooperative education will be realized by reading the list of the positions that the graduates have reached in the industrial world.

* * *

SELECTING WHEEL FOR GRINDING HOLES IN BUSHINGS

By CLAYTON WHEELER

A grinding machine operator who has only one kind of work to grind generally learns to do that one job well. He has an opportunity to experiment until he finds just the right combination of grinding wheel, speeds, feeds, and any other variable factors that may affect the quality and production. The operator who has a great variety of work ranging from the smallest to the largest pieces that can be handled on his machine, must have, or acquire, a wide knowledge of grinding methods.

Of course the operator who handles a great variety of work often finds it necessary to do more or less experimenting with different wheels, speeds, etc., as in the case of the bushing-grinding job described in this article. Where such a variety of work is handled, it is obviously impossible for the operator to remember the exact method found to be the most satisfactory for any particular job. For this reason it is important that records be kept of the methods finally proved to be the best for each new piece of work. These records can be referred to when work of the same kind or of a similar nature is again encountered.

The procedure in setting up a grinding machine for grinding the holes in a lot of bushings like the one shown in Fig. 1 will give some idea of the problems encountered in this class of work and the methods used in their solution. It will be noted that the inside diameter of the bushings is 2 inches, and the length 2 1/2 inches. Usually an internal spindle which would be suitable for this job would not carry a wheel wider than 3/8 inch. Assuming that a wheel 3/8 inch wide is to be used, the diameter may be from 3/4 to 1 3/4 inches. There is, however, just one size that will give the best results. The exact diameter must, in this case, be determined by trial or a process of elimination.

First we will assume that the largest wheel is tried out. This wheel is 1 3/4 inches in diameter and has a 3/8-inch

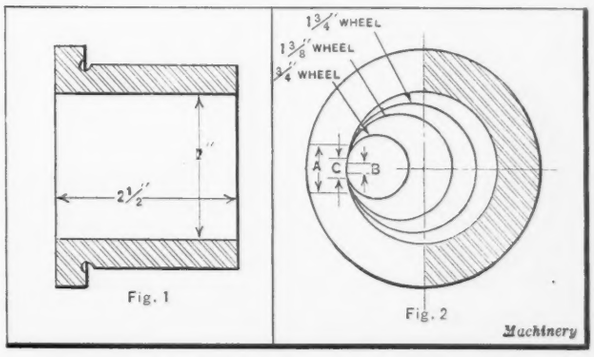


Fig. 1. Hardened Steel Bushing to be ground on the Inside

Fig. 2. Diagram showing Arcs of Contact of Different Sized Wheels

face. The feed is adjusted so that the table or work travel per revolution is a little over two-thirds the width of the wheel. This allows for an overlap and gives a smooth finish. The operator soon finds, however, that the wheel has become crystallized, and accordingly, he dresses it down, only to find that the work heats up in a little while as the result of crystallization. His next thought will be that the wheel or work speed is not suitable. If the speed of the work is too high, the stock is presented to the wheel faster than it can be ground away, thus causing crystallization. Therefore, the speed of the work is reduced and the grinding continued. It is found, however, that the wheel glazes up sooner than it did before, and the next move is to try the smallest wheel available, which is 3/4 inch in diameter.

The trouble with the larger wheel may not have been so much the matter of grain or grade, but that of unsuitable diameter. The wheel, being too near the same size as the hole, had too large a bearing surface in contact with the work. This produced more friction than a smaller wheel, and thus lessened the efficiency. Referring to Fig. 2, the dimension *A* represents the length of contact or bearing surface of the 1 3/4-inch wheel. The length of contact of the smaller wheel, as represented by dimension *B*, is obviously too small, and it is difficult to obtain a surface speed high enough for satisfactory results. The dimension *C* represents the length of contact of a grinding wheel 1 3/8 inches in diameter, which gave the best all-around results on this job. While a wheel of the exact diameter desired is not always available, it is generally best to select one that is slightly larger than that desired, as it will soon wear down or can be dressed down to the proper size.

Unusual Gaging Devices and Methods

Prize-winning Articles in MACHINERY's Contest on Interesting Gaging and Inspection Practice
Fourth and Last Installment

DEVICE FOR GAGING POSITION OF HOLES IN VALVE

By DOUGLAS P. MUIRHEAD

The device here illustrated was used to check accurately the positions of certain holes in relation to each other, the component being a special type of steam valve. In Fig. 1 the device is shown in position in a part-section *A* of the

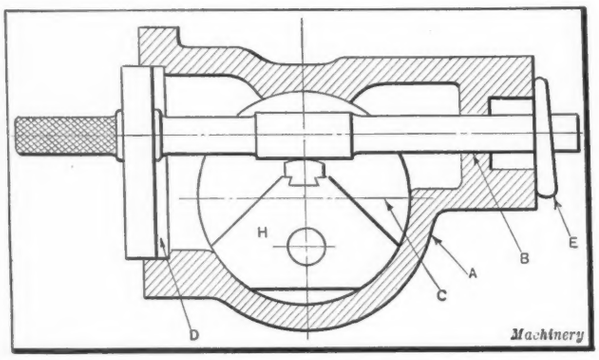


Fig. 1. Special Steam Valve with Gages in Testing Positions

valve. It will be noted that the three bores *B*, *C*, and *D* in the valve are not on the same center line, but are offset in relation to each other. These three holes are all machined within close limits, and their centers are checked in the following manner.

The fixture shown in Fig. 2 is inserted through the large hole *D*, Fig. 1, and pushed into place. This fixture consists of a hardened and ground bar *A*, Fig. 2, to which is secured a ground disk *B*. This disk is ground slightly tapered on the outside diameter to allow for the variation between the high and low limits in the bore *D*. At the opposite end of bar *A* there are two tapered slots *C* to accommodate the tapered wedge *E*, Fig. 1. This wedge draws the bar into position in the holes, and holds it there during the checking operation.

The fixture for checking the centers is shown in Fig. 3. This consists of a hardened and ground steel block *A* with a handle *B* attached to it. Block *A* is triangular in shape, and is ground at the points *D* so that the radius *R* is equal to the radius of hole *C*, Fig. 1. At the top of the block there is an inserted piece of hardened tool steel *C*, Fig. 3. This is ground to the radius *E*, on the same center as previously used in finishing the surfaces *D*. A series of steps are ground on this center, as shown at *H*, *M*, and *L*, these being the high, mean, and low limits allowed on the valve, between the centers of holes *C*, *B*, and *D*, Fig. 1.

It will be seen that by passing the step limit block shown in Fig. 3 through the main bore of the valve and below the

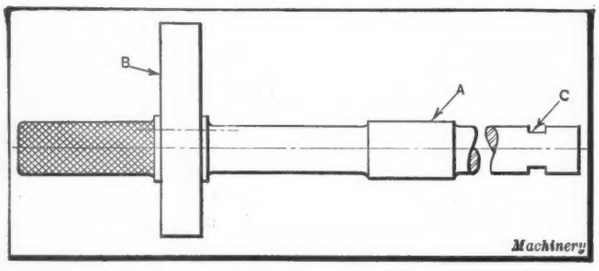


Fig. 2. Gage for testing Position of Bore D, Fig. 1

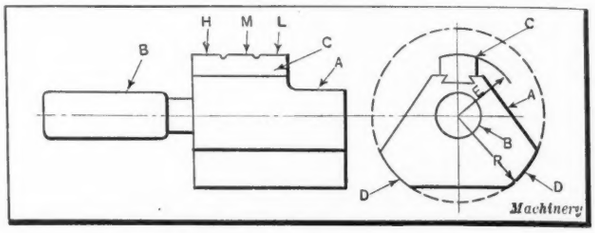


Fig. 3. Step Limit Block shown at H, Fig. 1

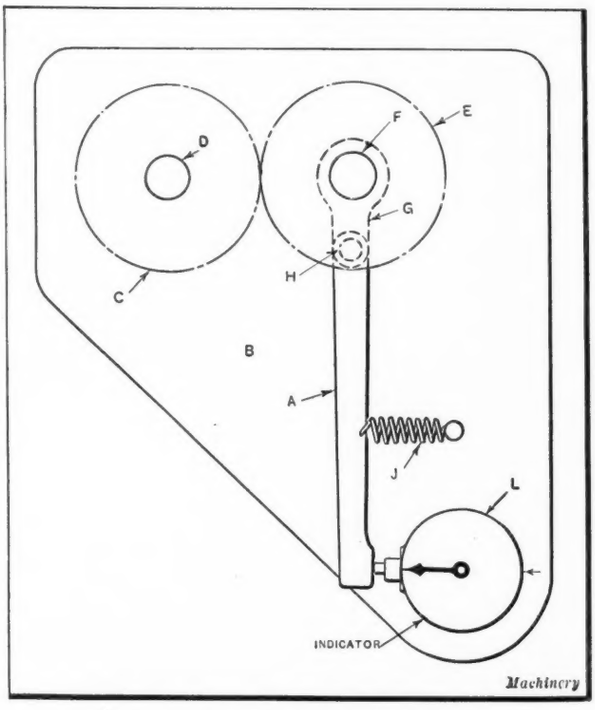
ground bar, it is possible to determine whether the centers are positioned at the high, mean, or low limit. A valve that has thus been gaged is stamped *H*, *M*, or *L*, according to the result of this test. The assembly of the internal fittings in a valve is then carried out according to the letter stamped upon the valve.

* * *

GEAR-TESTING FIXTURE

By GUS H. FROELICH

A fixture for testing the concentricity of gears that are required to be accurate within 0.0001 inch is shown in the accompanying illustration. A standard Brown & Sharpe in-



Fixture for testing Concentricity of Gear

dicator was successfully used in the manner described, to test the concentricity within this limit of accuracy. As the indicator is only graduated to 0.001 inch, an arm *A* with a 1 to 5 leverage was provided. With this arm in use, the graduations on the dial represent a movement of 0.0002 inch. By estimating one-half a graduation on the dial, accurate readings to 0.0001 inch are readily obtained.

Referring to the illustration, *B* is the base of the fixture, *C* the master gear, *D* the master stud (which is fixed), *E* the gear to be tested, *F* the stud mounted on the reduction

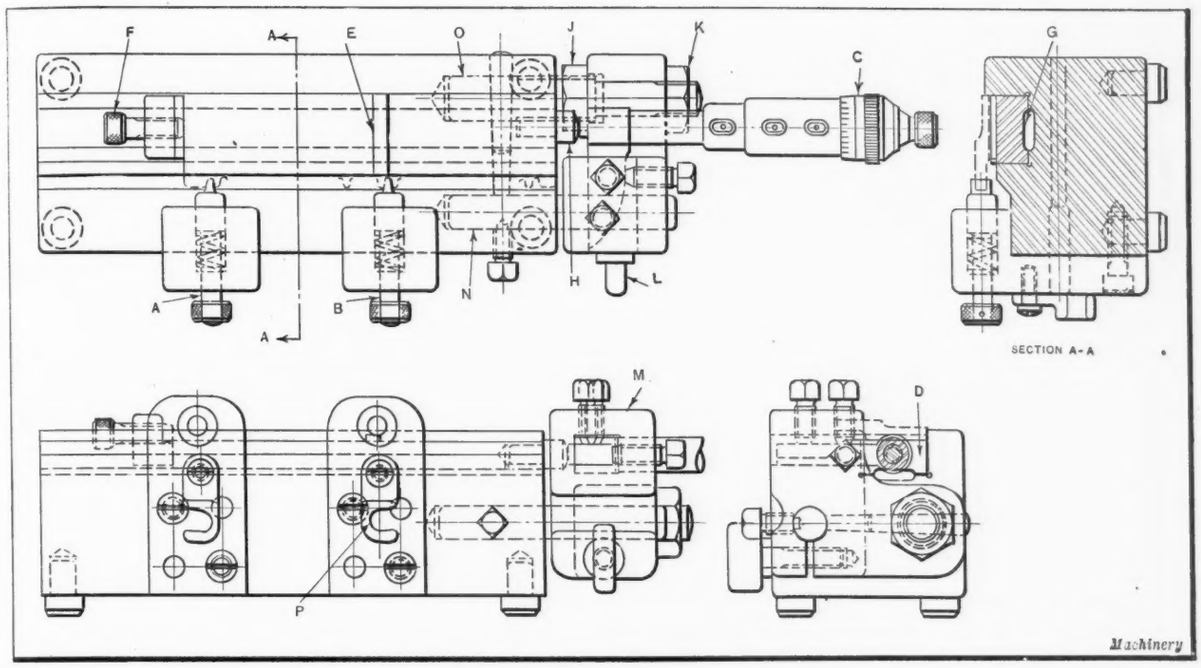


Fig. 1. Gage for testing Pitch of Part shown in Fig. 2

arm, *G* the short end of lever *A*, and *H* the fixed stud on which lever *A* is mounted. The spring shown at *J* keeps the gears in mesh while they are being revolved. The amount of eccentricity, if any, in the gear being tested is indicated by the dial indicator *L*. The end of arm *A* which makes contact with the indicating point is formed to a radius corresponding with the leverage obtained by arm *A*, so that the reading of the indicator will be uniform.

* * *

PITCH-TESTING GAGE

By EDWARD M. HEISER

The tolerance allowed on dimension *A* of the piece shown in Fig. 2 is very small, and it is necessary that all teeth be as nearly alike as possible. The gage devised for gaging the pitch of the individual teeth is shown in Fig. 1. In the upper view of Fig. 3, is shown the master, which is used to check the setting of the two plungers *A* and *B*, Fig. 1, and also to set the micrometer head *C* to 1.000 inch. The master is set in groove *D*, so that face *A* (Fig. 3) of the master is against the key *E*, Fig. 1. The thumb-screw *F* holds the master against this key.

The key *E* is an integral part of the slide *G* which slides in groove *D*. The thumb-screw *F* is located in a piece which is also fastened to slide *G*. After the plungers are inserted in the master, the micrometer is set to 1.000 inch, where it is held by set-screws in the block *M*, which slides on the two pins *N* and *O*. The contact point of the micrometer is then brought against button *H*, after which the two lock-nuts *J* and *K* and the thumb-screw *L* are tightened, making the gage ready for testing the piece.

The piece to be gaged is placed on slide *G* so that keyway *B* (Fig. 2) of the piece fits over the key *E* of slide *G*. Then the thumb-screw *F* is tightened. The spaces between the teeth are numbered for the full length of the piece, although most of the numbers have been omitted in the illustration Fig. 2. A chart is provided which gives the micrometer readings for the individual teeth. A reading with the plungers in spaces 1 and 17 is taken first. Space 17 is of different width from any of the other spaces, which necessitates the use of two plungers.

The mircometer is of the direct-reading type. This form lessens the possibility of error, and also facilitates the gaging of the piece. With the two plungers inserted, the micrometer should read 1.000 inch. After gaging the distance

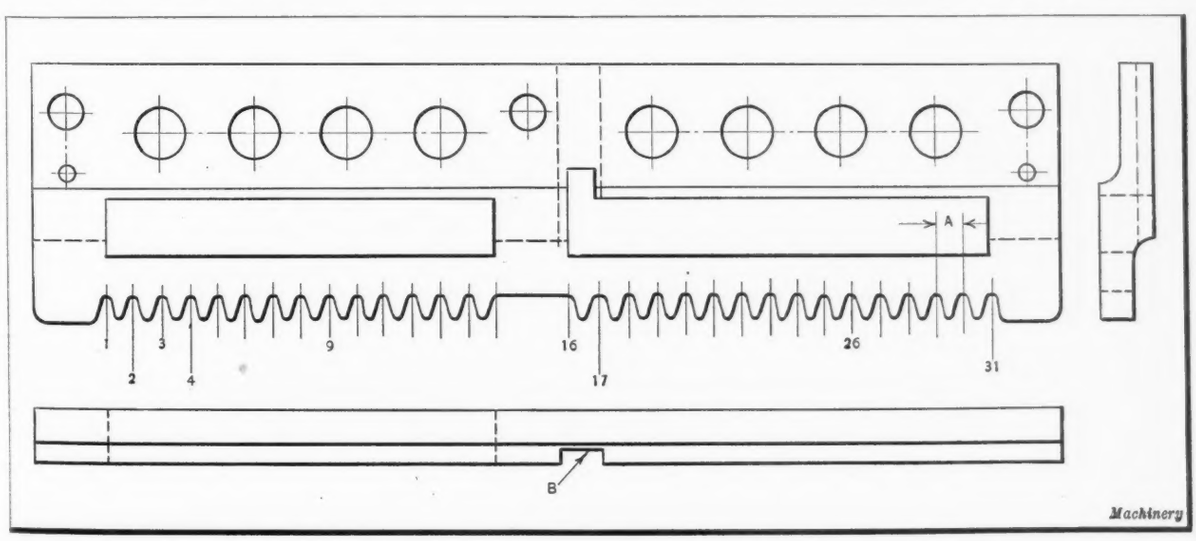


Fig. 2. Part tested in Gage shown in Fig. 1

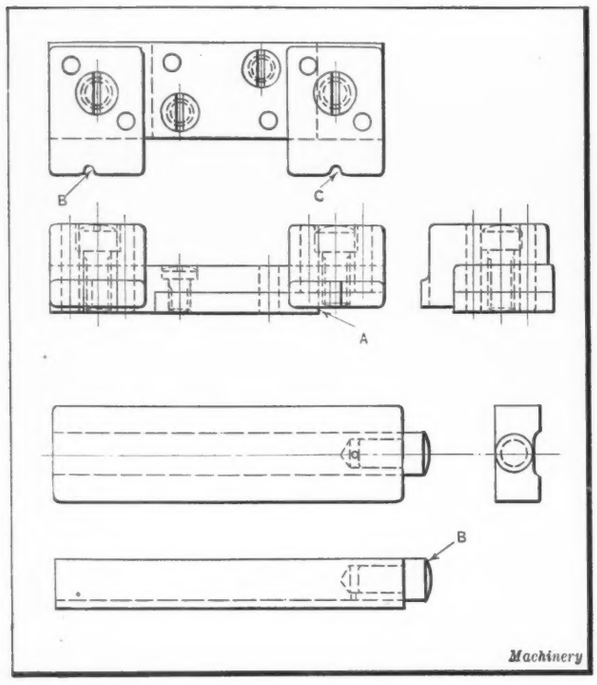


Fig. 3. Master and Working Gages used with Pitch-testing Gage

from 1 to 17, the plunger *A*, Fig. 1, is inserted in the next space. Plunger *B* is not needed until the next piece is gaged, and it is therefore held away from the piece by the swinging member *P*.

As the range of the micrometer is only 1.000 inch, it was necessary to provide four blocks of various lengths, like that shown in the lower view of Fig. 3. When the plunger is in space 9, Fig. 2, one block is used of a length which brings the micrometer reading back to 1.000 inch. With the plunger in space 16, another block is used, which brings the micrometer reading back to 1.000 inch. Space 18 would have given a reading in tenths of a thousandth which is undesirable, so another block was provided which also brings the reading back to 1.000 inch. The fourth block is used with the plunger inserted in space 26. This also brings the micrometer reading back to 1.000 inch. These gage-blocks slide in groove *D*, Fig. 1. The end opposite button *B* of the gage-block shown in the lower view of Fig. 3 rests against the button on the slide *G*, Fig. 1. The button *B* of the gage-block is then in contact with the micrometer spindle.

* * *

GAGE FOR TESTING SHAFT DIAMETER

By CHARLES A. WAHLGREN

The gage shown in the accompanying illustration was designed by the writer while employed as foreman of a lathe department. In this department a large number of shafts were required to be turned from 0.010 inch to 0.025 inch over the finish sizes.

In designing the gage illustrated, the chief object was to provide means for obtaining quick and accurate measurements. Five of these gages were made, as some of the shafts to be turned had five shoulders or steps. These gages were numbered from one to five, gage No. 1 being set to gage the smallest diameter, gage No. 2 the next larger step, and so on.

A master gage made from sheet steel, with steps of different sizes for setting the five gages, was made up and mounted in a cast-iron base. The steps on this gage range in size from 1/2 to 3 1/4 inches. The gage is set to the required size by loosening the thumb-nut *A* and sliding the movable jaw *B* down until the point of the indicator rests at the zero mark when the measuring jaws are in contact with the correct step on the master gage. A gage for each size to be turned is set in this manner. A movement of 0.001 inch of the contact point at *C* corresponds to a movement of 0.032 inch at the indicating point. It will be noted that only a small section of the metal cover *D* is shown in the illustration. This cover, however, extends the full length of the indicator and protects the moving parts of the gage.

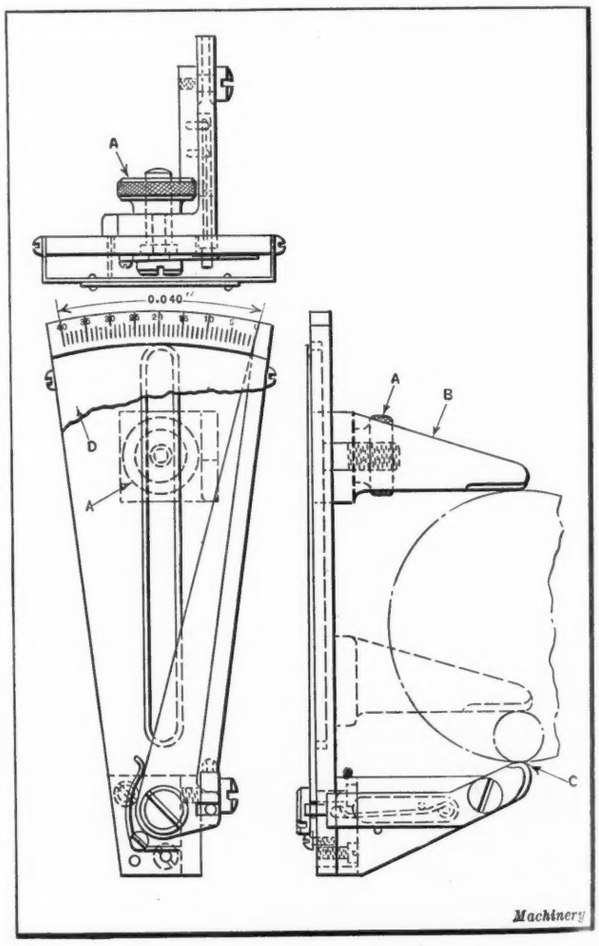
* * *

EXTRACTING BROKEN DRILLS

By THOMAS R. CHAMBERS

In drilling deep oil or grease holes in shafting or steel forgings, difficulty is often experienced due to a "piped" condition of the work. The usual result is that the drill is broken. When this occurs, it becomes necessary to remove the broken end of the drill from the forging before the work can be completed. Sometimes the drill point can be removed by rapping the work, or if this method is not successful, the piece may be heated so as to expand it a sufficient amount to cause the drill to be released. These methods, however, tend to destroy the accuracy and neat appearance of the machined surfaces and may cause the part to be rejected by the inspectors. The writer has endeavored to eliminate this trouble by using acid to remove the drill.

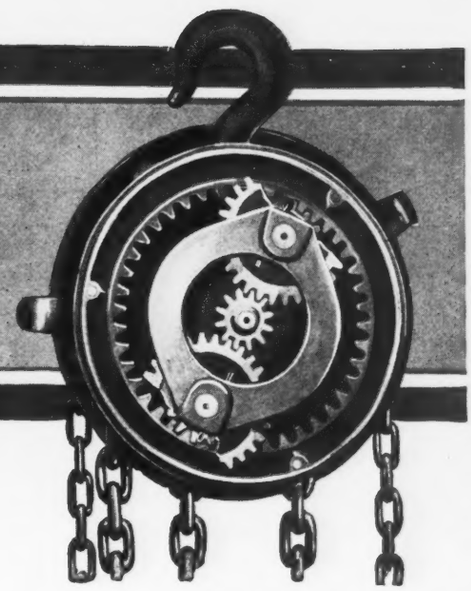
Of the various acids and mixtures tried, a mixture of nitric and hydrochloric acid has proved the most satisfactory. Three parts of nitric acid and one part of hydrochloric acid sometimes termed "aqua-regia" should be used. By placing the work in an inclined position, the acid mixture, which is poured into the hole at the top, will surround the broken drill. Care should be taken in handling the acids to see that they do not come in contact with the flesh, as they will cause severe burns. They will also burn or eat their way through clothing. Fresh acid should be added occasionally and the mixture agitated by inserting a wire in the drill hole, or by jarring the work. After the acids have been allowed to work for two or three hours, the drill will fall out when the work is jarred. If the acid boils over on the finished surfaces, it should be immediately washed off.



Gage for testing Shaft Diameter

Planetary Gearing

By FRANKLIN DeRONDE FURMAN
Professor of Mechanism and Machine Design
at Stevens Institute of Technology



Mechanism of Rope-making Machine—Planet Wheels Mounted on Eccentric—Special Applications of the Planetary Principle—Twelfth Article

THIS article will include a description of the planetary gear mechanism of a rope-making machine; the use of an eccentric to take the place of a train arm for supporting the planet wheels; a case in which the planet wheel is hung on three equal and parallel cranks, instead of being pivoted to a train arm; planetary gear action in mechanism in which ordinary toothed wheels are not used; a case in which the planet wheel rolls within a fixed internal wheel, thus obtaining the well-known mechanism used in the "trammel method" for drawing ellipses. (The notation used will be found at the end of the article.)

Planetary Mechanism of Rope-making Machine

The planetary mechanism used in Robinson's rope-making machine is illustrated diagrammatically in Fig. 62. Its object is to deliver each strand of a rope to the point in the final manufacture of the rope where the strands join, either with no twist whatever in the strand, or with a slight amount of twist to give the rope the necessary flexibility and resistance to unwinding. In the illustration, the train arm T and the disk G are keyed to the driving shaft S, and they contain the bearings for forks Y, which carry the spools or bobbins K on which the strands are wound. Forks Y are turned on their journals in T and G by the planet wheels D_3 which are driven by the internal wheel D. Wheel D is merely a ring supported by three sets of rollers, as indicated at Q, and gear teeth are cut both internally and externally on the ring, the external teeth meshing with the primary driving wheel J.

If the shaft and train arm of this rope-making machine are revolving at an angular velocity represented by AB, and if the internal wheel is driving at an angular velocity represented by AF, the two points A and P on the planet wheel D_3, and in fact all points on it, as well as all points on fork Y and bobbin K, are moving at equal and parallel resultant linear velocities AB and PE. At the phase shown, AF was so taken that PE would equal AB. This means that the bobbins have a motion of circular translation, and do not turn at all on their own axis while they are carried through the 360 degrees by train arm T and disk G. In this case,

$$N = \frac{AB}{AF} = \frac{5}{3.7}$$

or the train arm T must make approximately 1 1/3 turns while the driving ring makes one turn in order to deliver the strand to the final rope-making point at L, without twist. The exact answer is readily found by the proportion $AF:PE::AM:PM$. Since PE is taken equal to AB in this case, and if AB is taken arbitrarily as 5 units, and the machine is so proportioned that AM equals 6 units and PM

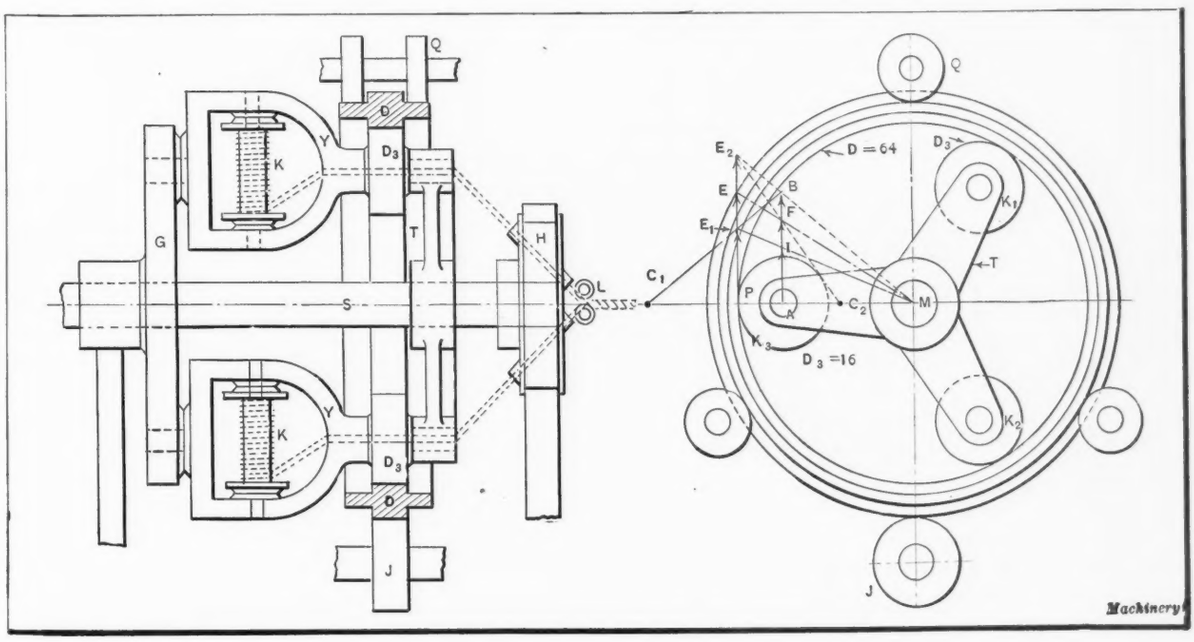


Fig. 62. Diagram illustrating Mechanism of a Rope-making Machine, including Graphical Solution

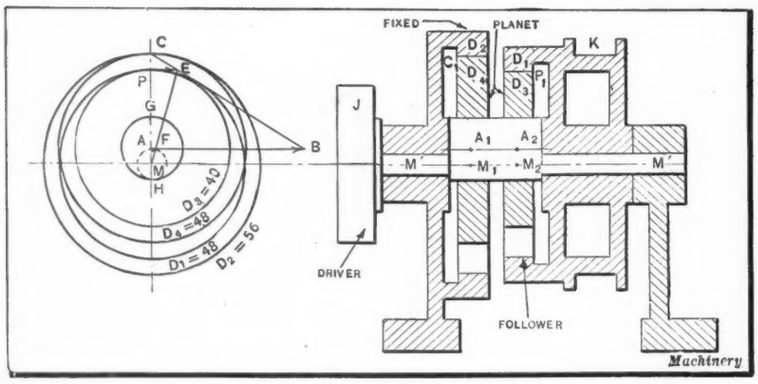


Fig. 63. Planetary Mechanism in which an Eccentric is used for supporting the Planet Wheels

equals 8 units, $AF = \frac{5 \times 6}{8} = 3.75$, whence $N = \frac{5}{3.75} =$ 1 1/3. Hence, the ring driver must turn at three-fourths the speed of the train arms with wheels of these proportions to give the bobbin a motion of circular translation.

If it is desired to give the strand a right-hand twist as it is laid into the rope at L, the speed of the driving ring D is increased. If it is increased, say, 33 1/3 per cent, then AF will represent the velocity of the train arm, and AB the 33 1/3 per cent increased velocity of the driving ring. This gives the two resultant linear velocities AF and PE_2 to the planet wheel, with its instantaneous center at C_2, and the planet wheel is turning about its center with an angular velocity measured by $\frac{AF}{AC_2} = \frac{3.75}{2.5} = 1.5$, according to this approximate method. Figured exactly by the geometrical method, that is, starting with $AF = 3\ 3/4$, $AP = 2$, and $PM = 8$, and computing values for AB and PE_2, AC_2 is found to equal $\frac{18}{7}$ and $\frac{AF}{AC_2} = 1\frac{11}{24}$. This, then, represents the number of turns or twist given to the strand while the main shaft S and train arm T make $\frac{AF}{AM}$ turns, or $\frac{3.75}{6} = \frac{5}{8}$ turn, or 2 1/3 turns of the strand while the train arm makes one turn. This is obtained by the analytical formula as follows:

$$N' = 1 + \frac{1}{3} \times \frac{D}{D_3} = 1 + \frac{1}{3} \times \frac{64}{16} = 2\ 1/3$$

If it is desired to give the bobbin a left-hand twist, the speed of the driving ring D is decreased, while the speed of the train arm remains the same. If the reduction is one-half that of the train arm, the relative speeds of the two members will be shown by AB and AI, and the planet wheel will be turning left-hand, or counter-clockwise, with a speed represented by $\frac{AB}{AC_1} = \frac{5}{6}$. This 5/6 of a turn of the planet wheel on its own axis takes place in a counter-clockwise direction, as indicated by the fact that C_1 falls to the left of A, while the shaft S and train arm make $\frac{AB}{AM}$ or 5/6 of a turn clockwise. In other words, the bobbin and the train arm each make one full turn in the same time, but in opposite directions. This is obtained by the analytical formula as follows:

$$N' = 1 - \frac{1}{2} \times \frac{D}{D_3} = 1 - \frac{1}{2} \times \frac{64}{16} = -1$$

Planet Wheels Mounted on Eccentric

An eccentric may be substituted for the train arm when it is desired to make the train arm so short that planet wheels cannot be mounted on pins carried by the train arm. This arrangement was adopted in the mechanism originally forming part of Nelson's steam steering gear. The use of the eccentric is of especial advantage when internal sun wheels are used. The characteristic of the eccentric in connection with planetary gearing is that it permits the use of comparatively large planet wheels which are almost as large as the sun wheels with which they gear, as shown in Fig. 63, where the planet wheels D_3 and D_4 are nearly as large as their respective sun wheels D_1 and D_2. The use of the eccentric in place of the train arm does not change the analysis used in the solutions of the regular train arm mechanisms.

In Fig. 63, M is the center of the drive shaft to which the independent driving gear wheel J is keyed. The outside diameter of the eccentric, which is integral with the drive shaft, is GH, and the center A of the eccentric travels in the circular path shown by the dotted circle AH, which corresponds to the circular path of the planet wheel pin when a regular train arm is used. The eccentric radius is MA, and its "throw" is HA. In all cases where an eccentric is used, the "throw" of the eccentric must be equal to the differences in diameters of the several pairs of mating sun and planet wheels.

The graphical solution for the planetary gear mechanism, using an eccentric instead of a train arm, is entirely similar to the solution given in elementary problem No. 8 in Article 3 of this series. In this problem A is the center of the eccentric and is driving with a velocity represented by AB. The point C is a fulcrum point on the fixed wheel D_2, which is integral with the framework of the mechanism, and PE is the linear pitch-line velocity of the follower annular sun wheel D_1. When PE is reduced to radius MA, to compare angular velocities, the answer by the graphical method is read at once as $N = \frac{AB}{AF}$.

The analytical solution is also readily written as explained in the case of Problem 8, and in following problems, as

$$N' = 1 - \frac{D_2}{D_4} \times \frac{D_3}{D_1} = 1 - \frac{56}{48} \times \frac{40}{48} = 1 - \frac{35}{36} = \frac{1}{36}$$

which is the exact answer, and interpreted means that while the follower wheel and drum K make one thirty-sixth turn, the driving shaft M and the eccentric make one turn, both in the same direction. Had wheel D_1 been constructed as the fixed wheel, and D_2 as the follower wheel, each remain-

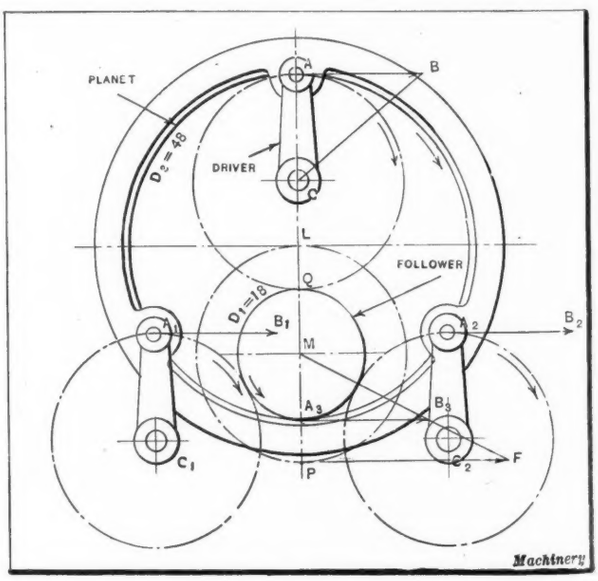


Fig. 64. Planetary Gear Mechanism with Internal Planet Wheel supported by Three Equal and Parallel Cranks

ing the same size, the latter would have turned in an opposite direction from the driving shaft M' and would have turned at a slightly greater speed than in the present problem.

Planet Wheel Pivoted on Three Equal and Parallel Cranks

A planetary gear mechanism in which the planet wheel is hung on three equal parallel cranks, thus giving it a motion of circular translation, instead of a motion of revolution as it would have if it were carried in the usual way by a pin in a train arm, is shown in Fig. 64. The fact that it has a motion of circular translation makes it an effective driver when working in conjunction with a follower wheel that has a fixed center of rotation. The planet wheel in Fig. 41, Article 8, also had a motion of circular translation, but it acquired this motion through two eccentrics instead of through three cranks as in the present case. However, the principles that apply are the same in both cases, and it is to be noted that in this type of construction it is essential that the "throw" of the crank, or eccentric, (diameter of the crankpin circle, or of the eccentric center circle) must be equal to the difference in diameters of the two engaging wheels D_3 and D_1, as in Fig. 64 where the cranks are used. It may be of some assistance, in understanding the mechanism, to note that if the pinion D_1 were held stationary and the three cranks were removed from D_3, the latter would be free to be rolled with its internal surface against the external surface of the pinion, and in this case, the center L of D_3 would travel in the path of the circle LP.

The graphical solution of this problem is shown in Fig. 64, where AB equals the resultant linear velocity of each of the three crankpins, and therefore AB is the resultant linear velocity of any point on the planet wheel D_3. Since D_3 engages the sun wheel D_1 at A_3, A_3B_3, equal to AB, must be the resultant linear velocity of the point A_3 on the follower. It is now only necessary to find the value of A_3B_3 at the unit radius CA, to which PM is made equal, in order to establish the angular velocity PF of D_1, as compared with AB of the driving crank. Therefore the formula $N = \dfrac{+AB}{-PF}$ gives the ratio of turns of the shaft at C to one turn of the shaft at M. Measured to any convenient scale, $N = \dfrac{+6}{-10}$, the plus sign indicating that the shaft C is turning clockwise, and the minus sign, that the sun wheel shaft M is turning counter-clockwise.

The analytical formula for the present problem is written:

$$N' = 1 - \frac{D_3}{D_1} = 1 - \frac{48}{18} = \frac{-5}{3}, \text{ or } N = -\frac{3}{5}$$

The numeral one in the formula indicates that D_3, as well as D_1, has turned once, clockwise, on its own center while

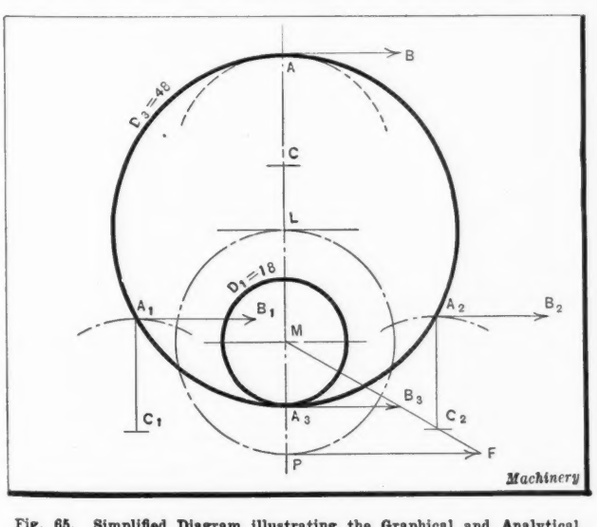


Fig. 65. Simplified Diagram illustrating the Graphical and Analytical Solutions of Mechanism shown in Fig. 64

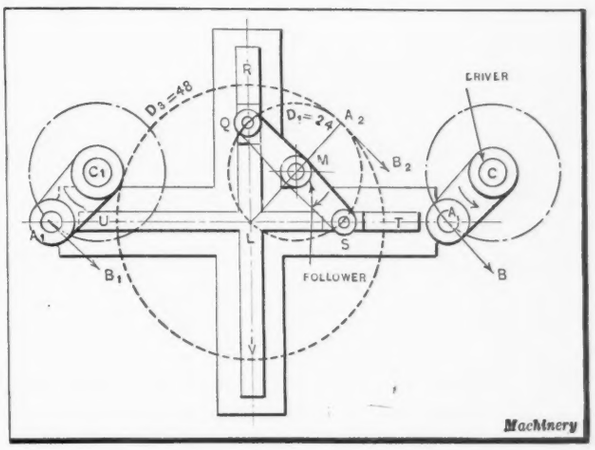


Fig. 66. Mechanism embodying Planetary Principle and designed to give a Reverse Motion without using Toothed Wheels

rotating the two wheels as one solid piece through 360 degrees, as discussed in connection with Problem 12 in Article 4. But D_3 is not entitled to this turn, as it has a motion of circular translation given to it by the three cranks, so that it must now be rotated once, counter-clockwise, on its own center L. During this rotation it gives wheel D_1, $\dfrac{D_3}{D_1}$ turns in a counter-clockwise direction, from which consideration the minus sign in the formula and the term $\dfrac{D_3}{D_1}$ are obtained. The final interpretation of the formula is that the sun wheel D_1 makes five turns counter-clockwise while planet wheel D_3 makes three turns clockwise. In Fig. 64, the physical outline of the mechanism is shown in order to explain the construction of the mechanism more clearly, but all that is really necessary for the graphical and analytical solutions is shown in Fig. 65.

Planetary Mechanism without Toothed Gearing

If it is desired to produce a reverse motion with equal speeds, the planetary gear principle may be used without the construction of any ordinary toothed wheels, as illustrated in Fig. 66. The mechanism consists of a slotted cross RV and UT, hung on two equal and parallel cranks which have fixed centers at C and C_1. A bar QS turns on a fixed pivot at M, while the pins at Q and S turn freely in short blocks which slide in slots in the cross. The block at S slides the full distance from T to U in one cycle, and the block Q from R to V. The center of the cross travels in the path of the circle whose center is at M. The cross takes the place of an internal planet wheel as represented by a heavy dash-line circle whose center is at L, and the bar takes the place of the sun wheel whose center is at M.

The fact that this cross and bar are equivalent, mechanically, to an internal gear and a mating pinion of half the size of the wheel, is a fairly well-known fact, and as a demonstration of this, it is sufficient to say that this action is based on the geometrical proposition that when a circle rolls on the inside of another circle which is double its size, any point on the smaller rolling circle will generate a straight diametral line in the larger circle. The diametral line in this instance is the limiting case of the hypocycloid; consequently the points Q and S, which are at the extremities of the bar and are on both the small circle and the diametral lines of the large circle, will continue to move on the diametral lines, and the small blocks at Q and S, while traveling in the path of a circle, will slide freely in the slots TU and RV.

The graphical construction showing the relative speeds of the driving shaft C, Fig. 66, and the follower shaft M is made by taking any length of line AB to represent the speed of shaft C. Since the two driving cranks AC and A_1C_1 are equal and parallel, the cross must have a motion of circular

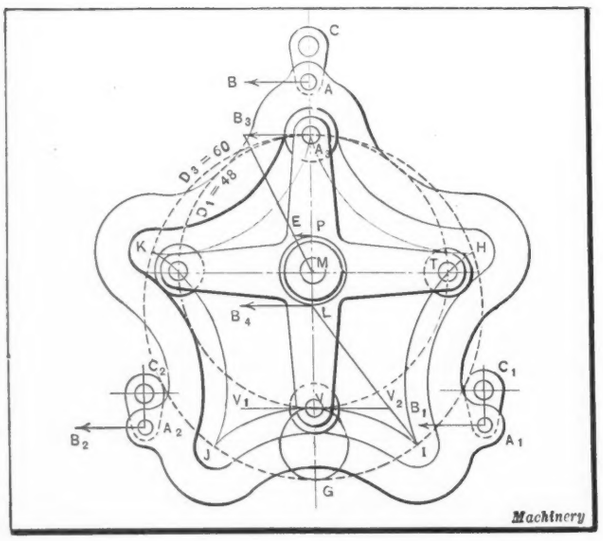


Fig. 67. Cross-and-star Type of Hypocycloid Gear

translation, and all points on it must have equal and parallel resultant velocities at any phase. Also, since the cross and an equivalent internal wheel are identical in this problem, an internal wheel will have a resultant velocity A_2B_2 where it engages the smaller wheel which is equivalent to the bar. Then A_2B_2 is the resultant linear velocity of shaft M measured at the radius MA_2, and as AB is the resultant velocity of shaft C measured at radius CA, and CA and MA_2 are equal by construction, $N = \frac{-AB}{+A_2B_2}$. Measuring these lengths to any convenient scale, $N = \frac{-4}{+4} = -1$, or the shaft M makes one turn clockwise while the shaft C makes one turn counter-clockwise.

The analytical solution is similar in every respect to that explained in connection with the preceding problem where three cranks were used, the formula being

$$N' = 1 - \frac{D_3}{D_1} = 1 - \frac{48}{24} = -1, \text{ or } N = -1$$

assuming that the numbers of teeth, or the pitch diameters of the equivalent wheels are 48 and 24, as indicated in Fig. 66.

In connection with a later problem on the subject of the Oldham coupling, it is essential to note that point L of the cross has the same motion as A of the arm AC, and that this point L is therefore turning counter-clockwise about the center M. But the arm QS is turning clockwise about the center M; therefore it would be possible to construct an arm ML turning freely on the pin at M, and this arm would turn twice on the pin for each turn of the arm AC.

A planetary gear mechanism that is completely disguised so far as the use of circular wheels and ordinary tooth forms are concerned is illustrated in Fig. 67. This mechanism was originally used in Elihu Galloway's "epicycloidal multiplying gear," in which one left-handed turn of the central four-armed "spider" gave four right-handed turns to each of the three arms AC, A_1C_1, and A_2C_2, which support the star-shaped ring within which the spider has a relative rolling action. This mechanism is shown reduced to its simple planetary circular gear wheel equivalent in Fig. 68. The equivalent internal planet wheel D_3 has 60 teeth, and the sun wheel D_1, having a fixed center at M, has 48 teeth.

The graphical solution is laid down by considering that every point of the planet wheel D_3 is given a resultant motion AB (Fig. 67) by the three equal parallel cranks AC, A_1C_1, and A_2C_2. The engaging point A_3 of the follower sun wheel D_1 must, consequently, have the same resultant motion, but its motion is about M as a center. Therefore the velocity at the radius MP, which radius is equal to CA, is PE, and PE and AB may now be directly compared, whence $N = \frac{+AB}{-PE}$. The plus sign is used in the numerator because crank AC and planet wheel D_3 are being turned in a clockwise direction. The minus sign appears in the denominator because D_1 is turning counter-clockwise.

The analytical formula is written the same as in the two preceding problems,

$$N' = 1 - \frac{D_3}{D_1} = 1 - \frac{60}{48} = -\frac{1}{4}, \text{ or } N = -4$$

This means that four circular translations of D_3, or four revolutions of the crank AC clockwise, gives one revolution, counter-clockwise, to the follower wheel D_1. Or, considered as it was originally applied, one turn of the wheel D_1 gives four cycles of circular translation, in the opposite direction, to D_3, or, four turns to each of its three supporting cranks AC, A_1C_1, and A_2C_2.

In problems such as the preceding one, the relative sizes of the equivalent sun and planet wheels cannot be taken arbitrarily. The essential requirement is that the diameters of the equivalent pitch circles, such as D_1 and D_3, Fig. 68, must be to each other in the same ratio as two successive whole numbers. In the present problem D_1 is to D_3 as 4 is to 5; 5 to 6, 9 to 10, or any other such ratio may be used. The reason for this requirement is that it will give a definite number of complete branches of the hypocycloids in the larger or internal wheel, there being five such complete branches as shown in Fig. 67, from A_3 to H, from H to I, etc. Each branch of the hypocycloid corresponds to a tooth in a regular internal toothed wheel. Furthermore, the smaller of the two numbers of the ratio will give the number of arms on the spider MA_3, MT, etc., or what is the same thing, the number of rollers that correspond to the number of teeth on the "pinion gear" that mates with the hypocycloidal internal gear. In this problem, there are four rollers, the ratio being 4 to 5, as stated previously.

In connection with the drawing of the hypocycloid in the previous problem, a curious geometrical case arises (evidently but little known) which may be made use of, perhaps, in acquiring an understanding of this part of the problem. The hypocycloid, unlike most other geometrical curves, is capable of two distinct generations. In Fig. 67 or 68, if the internal wheel is held stationary and the wheel D_1 is rolled inside of it, the point V on D_1 will generate a hypocycloid, and when D_1 has rolled until it has measured its own circumference off five times on D_3 the point V will have described five full branches of the hypocycloid, and this curve then returns to itself and will be duplicated exactly, in both size and position, if the rolling is continued.

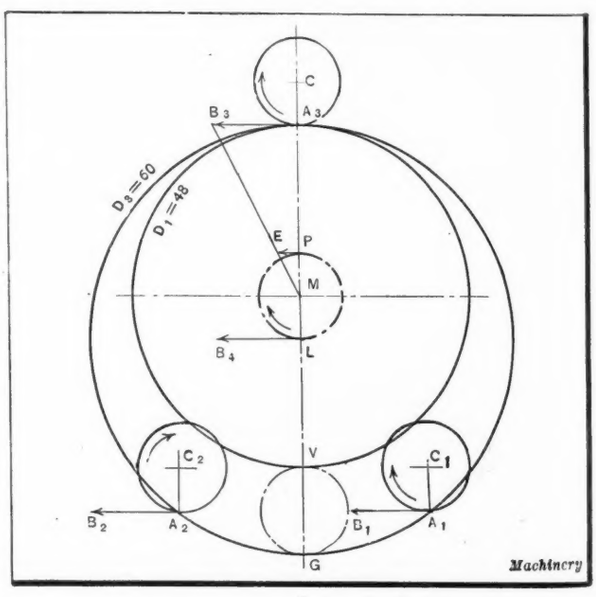


Fig. 68. Simplified Diagram of Mechanism shown in Fig. 67

This direct rolling of D_1 on D_3 is the usual way of thinking of the generation of the hypocycloid; but the unusual though simpler method when the pinion diameter is greater than the radius of the internal wheel, is to take the complementary circle VG, the diameter of which is equal to the difference in diameters of the two given wheels, and to roll this complementary circle on the internal circle. Then the point V on the complementary circle VG will generate exactly the same hypocycloid as the point V on the circle VA_3 did, and when the circle VG has rolled until it has measured its circumference off five times on D_3 it will have returned to its starting position exactly, and the point V will have completed the tracing of five full branches of the hypocycloid.

For the actual detail of drawing an exact hypocycloid, anyone not familiar with the method may refer to textbooks on mechanical or engineering drawing. A very close and quick approximation to the true hypocycloid may be made by stepping off, with a divider, the semicircumference VG, Fig. 67, on the internal gear pitch circle as at GI, drawing the radial line IL, and also a line at V tangent to the circle GV. Then one of the French or irregular curved rulers may be used, set so that the end having the shorter radius of curvature is tangent to the radial line at I, and the larger end is tangent to the straight line at V_1V_2. The half IV of the full branch IJ of the hypocycloid may now be drawn, and the remaining half branches drawn in a similar manner.

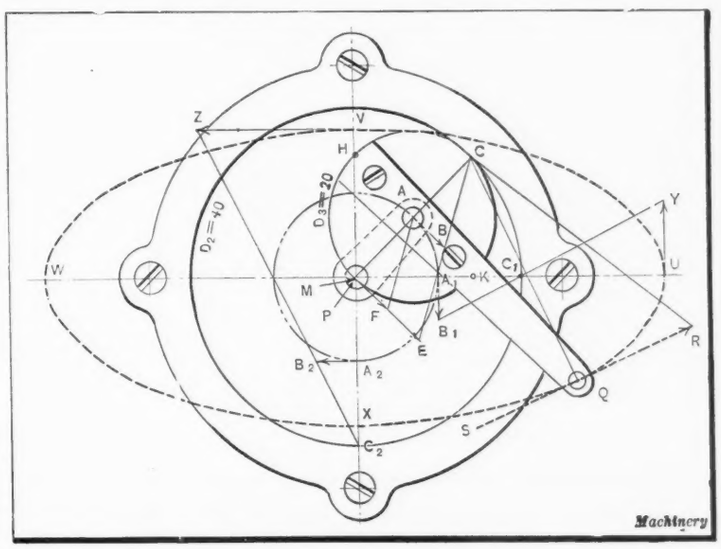


Fig. 69. Trammel Method of drawing an Ellipse—Equivalent to a Planetary Mechanism

The two previous problems have consisted principally of an internal gear wheel and a pinion, the former being the planet wheel and the latter the sun wheel with a fixed center. If now the internal wheel is made to have a fixed center, and the pinion is allowed to become the planet wheel, an entirely different application of these two mechanical parts may be made, particularly if the planet wheel is made one-half the size of the sun wheel. In the latter instance, the problem is similar, in general principle, to that illustrated in Fig. 14, Article 4. In that case the planet wheel rolled externally on the fixed sun wheel; in the present instance the planet wheel rolls around an internal fixed sun wheel, as illustrated in Fig. 69. The planet wheel turns once on its own axis while the driving train arm MA turns once on its axis, but they turn in opposite directions. This is shown by the graphical method of solution, as illustrated in Fig. 69, from which

$$N = \frac{+AB}{AM} \div \frac{-PE}{PC} = \frac{+AB}{AM} \div \frac{-PF}{AM} = \frac{+AB}{-PF}$$

Measuring these values to any scale and substituting,

$$N = \frac{+2}{-2} = -1.$$

The scale here used was such that $AB = 2$.

The analytical method of solution is written

$$N' = 1 - \frac{D_2}{D_3} = 1 - \frac{40}{20}$$

where D_2 has 40 teeth and D_3 has 20 teeth.

Then $N' = -1$, or $N = -1$. Although the planet wheel makes but one turn, counter-clockwise, on its own center, it makes two turns relative to the pin at A on which it is mounted. If the pin A and the hub of D_3 were threaded, as was the case in Fig. 14, Article 4, the planet wheel would have moved along the pin a distance equal to twice the pitch of the thread. The reason for this is that the pin A, although it is fixed in the arm MA, turns once clockwise on its own axis while the arm MA is turned through 360 degrees, as explained in connection with Fig. 14.

The mechanism shown in Fig. 69 illustrates the principle underlying the "trammel method" of drawing an ellipse. Those familiar with that method will recall that it consists simply in laying off one-half of the major axis of the ellipse on the straight edge of a card, as at QH, and one-half of the minor axis as at QK. Then the card is adjusted so that the point H is on the minor axis, and the point K on the major axis, in which case the point Q will be on a point in the ellipse. This adjustment is made as many times as desired, thus obtaining a series of points through which the curve may be drawn. To construct a planetary gear mechanism that will accomplish the same result, it is only necessary to take a planet wheel whose diameter is equal to the difference between the semi-major and semi-minor axes of the ellipse, and roll it inside of a circle of double its size. Then an arm rigidly attached to the planet wheel along a diametral line will move so that any point in the arm, such as Q, will travel in the path of an ellipse. The fundamental principle on which this is based is that a point in the circumference of a circle which rolls on the inside of a circle double its size describes a straight diametral line in the larger circle, this line being a limiting case of the hypocycloid.

In the present problem, if HQ is the semi-major axis of an ellipse, and KQ the semi-minor axis, it will be seen that these semi-axes are so laid out that H and K fall on the circumference of the smaller circle, and also on diametral lines of the larger circle. Thus, in accordance with the law of the hypocycloid, these points will continue to move along their respective diametral lines as the circle D_3 rolls inside the circle D_2. Hence the points H and K are moving along straight lines at right angles to each other, whether regarded as two points in a trammel, or as two points in a rolling circle, and the two devices are mechanical equivalents so far as the construction of the ellipse is concerned.

The graphical method for solving the planetary action in the mechanism shown in Fig. 69, needs only a few additional lines to enable one to draw a tangent to the ellipse at any desired point and to determine the velocity of the point Q that is generating the ellipse. To find the tangent to the ellipse at Q, it is only necessary to consider that C is the instantaneous center for the planet wheel D_3 at the phase shown, and that every point in the planet wheel, or in the arm that is rigidly fastened to the planet wheel, is at that phase moving about C with a motion of simple revolution. Therefore the point Q must be moving, at the phase shown, at right angles to the line CQ, and SR therefore becomes the tangent to the ellipse at Q.

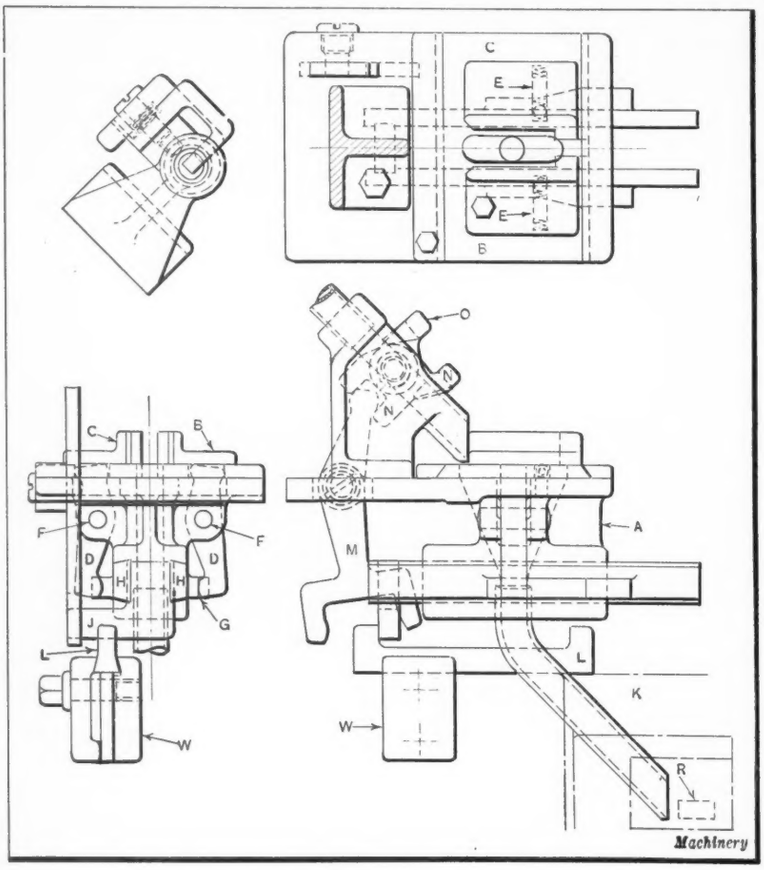
To find the velocity of Q at any phase, it is only necessary to consider that the point A was originally assumed to have a linear velocity AB, and this gives an angular velocity about C represented by the angle ACB. Therefore, if an

angle QCR is laid off equal to ACB. QR will represent the velocity of Q at the phase shown. To find the velocity of the point Q when it is at U, it is to be noted that A will then be at A_1, having a velocity A_1B_1 equal to AB, and that D_2 will then be tangent to D_2 at C_1. This latter point will be the new instantaneous axis; hence, $A_1C_1B_1$ will represent the angular velocity of all points on the arm, and UY will be the linear velocity of the generating point when it is at U. According to similar methods, VZ is found to be the linear velocity of the point Q when it is at V.

Notation

N = number of turns of driver to one of follower or driven member;

N' = number of turns of follower to one of driver;



Device for feeding Taper Rolls into Centerless Grinding Machine

N_1 = number of turns of driver to one complete revolution of planet wheel axis;

N_2 = number of turns of follower to one complete revolution of planet wheel axis;

D = diameter of pitch circle of driver, if driver is a toothed wheel; (The driver, or the follower, may be the "train arm," and not one of the toothed wheels, according to the data of a problem.)

D_1 = diameter of pitch circle of follower, if follower is a toothed wheel;

D_2 = diameter of pitch circle of fixed wheel; and

D_3, D_4, etc., = diameters of pitch circles of planetary wheels.

* * *

The first applications of electric motors in the textile industry are said to have been made in 1893 at the Columbia Mills Co., Columbia, S. C. Fourteen of the motors then installed are still in service. The normal rating of these motors is 65 horsepower. At the time the motors were installed, they were the largest of that type that the General Electric Co. had built. The largest three-phase induction motors built before that were of 10 horsepower.

DEVICE FOR FEEDING TAPER ROLLS

By GEORGE F. SCHAEFER

The device here described was designed for taking taper rolls, of the kind used in roller bearings, from a hopper, selecting these rolls, and feeding them small end first into a centerless grinding machine. The hopper used is of the type generally applied to thread-rolling machines. The center board is arranged with a V-groove in place of the usual slot, and the rolls are picked up and allowed to slide down into the selecting mechanism lengthwise.

The mechanism, as laid out in the illustration, is shown depositing a roll R into the fixture ready for the feed-bar K to come back and pick it up. The feed-bar is actuated by a cam on the opposite end of the machine (not shown in the illustration). The body A of the fixture is fastened to the hopper by a bracket. Sliding on body A are two plates B and C, retained by gibs. These plates are moved inward by pawls D and outward by compression springs E. Pawls D are oscillated about pivot pins F by the action of the cam surfaces G on slides H which are dovetailed into the body.

Recessed into slides H is a dog J. Another dog L is attached to feed-bar K, and is held in adjustment by clamp W. Pivoted in the body is a bellcrank M, the forked end of which straddles dog J, while the ball end meshes with a fork on the escapement pawl N. The function of the escapement pawls N and O is to cut off the feed of the rolls, as they come down from the hopper, and allow them to slide down one at a time on plates B and C.

In operation, the fixture works as follows: Feed-bar K is shown in its maximum "in position," and a roll R has been deposited ready to be picked up by the feed-bar on its return. Plates B and C are in their open positions, and escapement pawl N is shown holding back the rolls in the feed-tube. As the feed-bar returns, one of the projections on dog L engages dog J and carries slides H outward, forcing plates B and C inward through the action of pawls D which ride on the cam surfaces on slides H.

As dog J continues its outward movement it engages a prong on bellcrank M, causing it to pivot in the body and oscillate the escapement pawl enough to allow one roll to slide out on plates B and C. The remaining rolls in the line are retained in the feed-chute by pawl O, which bears on the top of the following roll. As feed-bar K completes its stroke, the roll at R is fed down by a finger (not shown), and the feed carries it between the grinding wheels on its return stroke. While the feed-bar is on its return stroke, the outer projection on dog L engages dog J, carrying the slides H inward.

Pawls D ride down the cam surfaces on the slides, and the compression springs E force plates B and C outward. During this outward movement of the plates the small end of the roll tilts downward, and as the plates continue to move apart, the small end drops through, leaving the roll suspended by its large end between the plates. The plates continue outward, allowing the roll to drop small end first through the feed-chute into the position R. Meantime bellcrank M is engaged by the dog J and oscillates pawl N downward. Pawl O is carried up and the rolls slide forward against pawl N, thus completing one cycle.

* * *

According to the National Chamber of Commerce, the United States made 90 per cent of the world's production of automobiles in 1924.

Letters on Practical Subjects

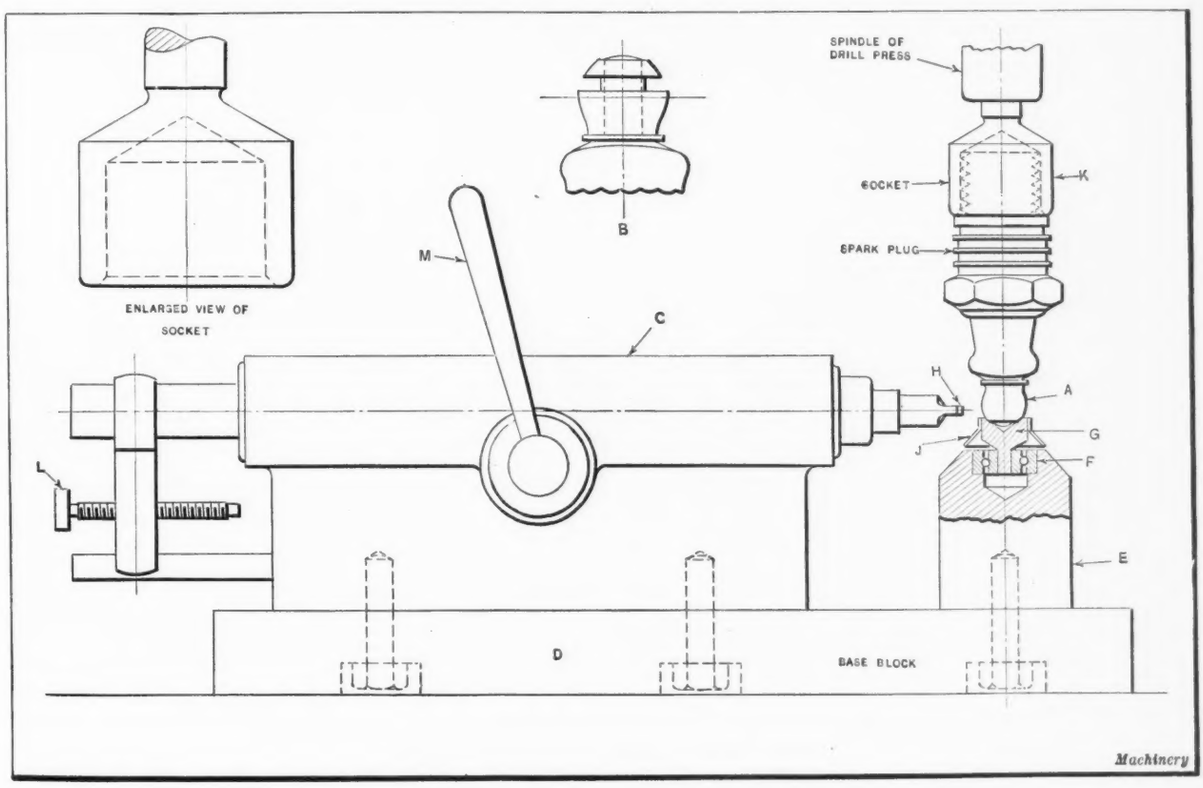
FIXTURE FOR GROOVING SPARK PLUGS

Recently a job came into the shop that necessitated converting 20,000 commercial spark plugs from a plain ball end, as shown at *A* in the illustration, to a grooved-type end, as shown by the enlarged view at *B*. It was found that the ball did not line up in most cases with the thread at the lower end of the plug, and therefore it was impossible to center the plugs by holding the threaded ends in a chuck. The groove was required to be cut to such a depth that the thickness of the metal between the top of the thread and the bottom of the groove was only 0.01 inch. Any slight inaccuracy in centering the work would therefore result in spoiling the part.

At first it appeared that the cost of cutting the grooves would be prohibitive, but finally a simple but effective device was made which solved the problem satisfactorily. A plain lever tailstock *C* from a small bench lathe was mounted on the base *D* as shown. On plate *D* was also mounted a block *E*, which carried at its upper end a small radial ball bearing *F*. In this bearing was fitted a socket *G* which supported the ball end of the spark plug at the correct height for grooving with the tool *H*. A thin sheet-metal apron *J* was fitted over the socket to keep the metal chips from finding their way into the ball bearing. The threaded end of the spark plug was located in a socket *K*. This socket was a loose fit over the threaded end of the spark plug, and was held in the spindle of a sensitive drill press by a tapered shank. An enlarged view of the socket *K* is shown in the upper left-hand corner of the illustration. The grooving tool *H* was made with a taper shank to fit the lathe tailstock, and the cutting end was ground to produce a groove of the required depth.

After setting up the base block *D* on the table of the drill press, and lining it up so that the socket *G* was directly under the drill spindle, the screw *L* on the tailstock was adjusted to stop the feeding movement of the tool when the groove had been cut to the required depth. The spark plug to be grooved was held in an inverted position with the ball end *A* resting in the lower socket *G*.

The method of performing the grooving operation was as follows: The ball end of the spark plug was placed in the



Equipment used in grooving Spark Plug Terminals

lower socket and the feed-lever depressed, lowering the upper socket over the threaded end of the spark plug until the lower edge of the socket rested on the flange of the plug. A slight additional pressure on the lever then caused the spark plug to rotate at the same speed as the drill spindle. While the workman held down the drill feed lever with his right hand, he fed the grooving tool forward by means of the lever *M*. As the stop *L* made it impossible for the workman to cut the groove too deep, no care was required in operating the tool, which was fed in as fast as the soft brass could be cut.

While the fixture was set up by a toolmaker, the actual work of grooving the spark plug was performed by a comparatively unskilled workman. After becoming accustomed to the operation, the workman was able to groove seven spark plugs in one minute. Of course, this speed could not be maintained for a long period, the average production being from 200 to 250 spark plugs per hour.

Pensacola, Fla. FRANCIS M. WESTON, JR.

FRICTION CHUCK FOR DRIVING SCREW-EYES

A large number of screw-eyes were to be driven into thin wood, the requirements being that they all be driven to the same depth, and that they all face the same way. In order to facilitate the work, the chuck shown in Fig. 1 was designed. This chuck was mounted on the spindle of a drilling machine. The outer shell *A* revolves with the drill press spindle *B*. Part *C* revolves freely within *A*, being retained by the washer *D*. Shell *A* is splined on the inside so that the eight disks *J*, formed with ears or tabs on the outside, will be carried around with it. The arrangement of these disks is shown in section *X–X*.

It will be seen that the holes in disks *J* are large enough to permit the squared shank of part *C* to revolve freely within them. The shank of part *C* carries eight circular disks *K*, having a square hole in the center, so that they will turn with part *C* and will revolve easily within shell *A*. Part *C* is made with a shoulder which turns in shell *A*, while the inner end of part *C* is turned to form a pilot, which fits into the back of shell *A*, serving to hold the part *C* central without placing any strain on the disks.

The disks are assembled alternately, so that when pressure is brought to bear downward against the screw-eye, they will be brought into firm contact, the frictional adhesion between the disks serving to carry the part *C* around with the shell *A*. Part *C* is grooved at the bottom for the insertion of the screw-eye, and carries a square pin *I* which acts as a stop.

In Fig. 2 the chuck *A* is shown in position in the drill press. The column of the machine carries two stops *G* and *H*, which are held in clamp brackets *E* and *F*. Stop *G* is a

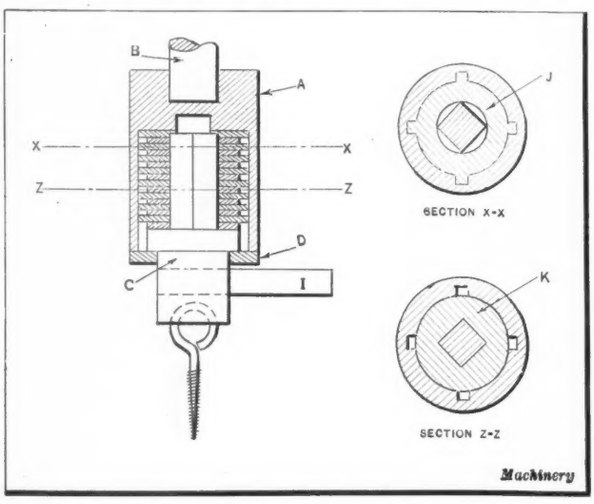


Fig. 1. Sectional View of Chuck for driving Screw-eyes

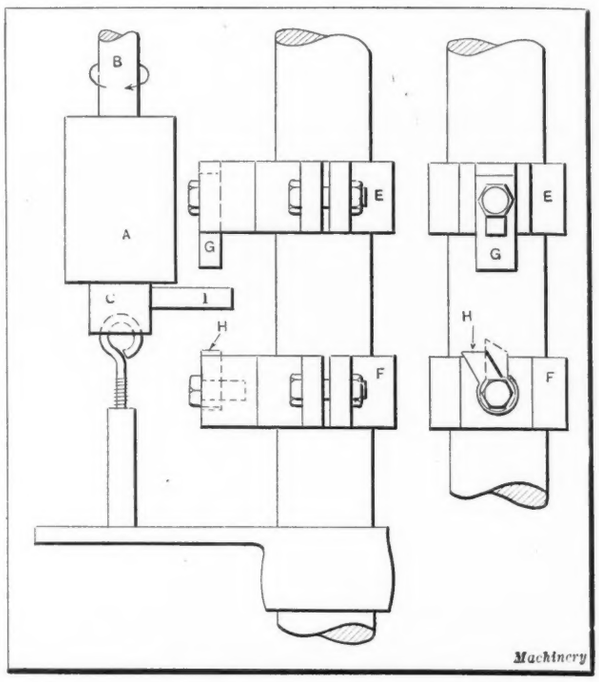


Fig. 2. Chuck and Stops used on Drill Press for driving Screw-eyes

slotted block, fitting freely in a groove in bracket *E*, so that it will assume the position shown, by its own weight. When the spindle *B* is in its upper position, the stop *I* rests against the edge of stop *G*, which serves to hold the part *C* stationary for the insertion of the screw-eye.

As spindle *B* is fed down, stop *I* rides off the bottom of stop *G*, and the pressure of part *C* against the screw-eye creates sufficient frictional adhesion between the disks to carry it around with shell *A*. As the spindle *B* reaches the bottom of its stroke, stop *I* on the chuck comes in contact with stop *H*, which serves to stop the motion of part *C*.

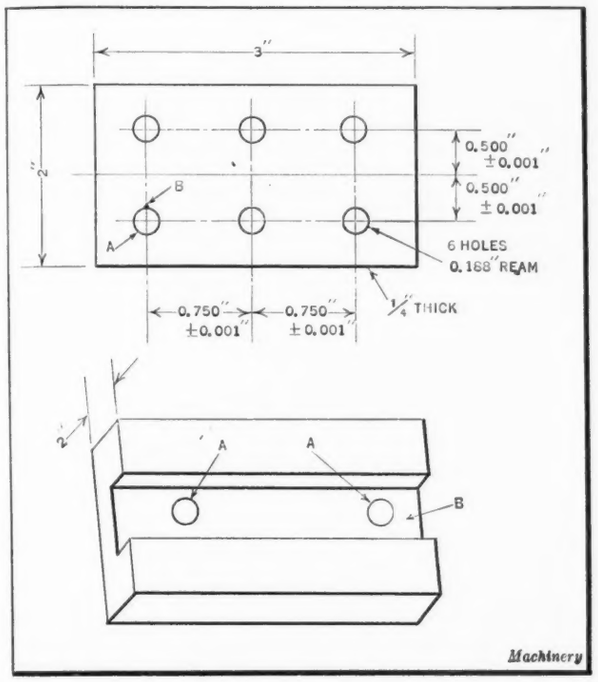
Stop *H* is a swinging pawl, as shown in the view at the right in Fig. 2. As soon as stop *I* strikes the corner of stop *H*, the latter swings on its pivot, causing the point of *H* to be lifted and swung into the position shown by the dotted lines. This provides a larger bearing surface to receive the shock of the sudden stopping of part *C*. As the spindle *B* is raised, stop *H* is returned to its original position by a spring, and stop *I* again comes in contact with stop *G*. Stop *G* is slotted so as to slide in its bracket; thus, in case stop *I* should strike in the center of stop *G*, breakage of stop *I* would be avoided. This chuck has been found to operate exceptionally well at high speeds.

Philadelphia, Pa. R. H. KASPER

MAKING INEXPENSIVE JIGS

In making plans for the manufacture of a small lot of machine parts, it is often difficult to decide whether or not a drill jig should be provided. If the parts are drilled without a jig, the job may prove to be a tedious one. On the other hand, if a jig is made, the cost of the jig may exceed the gain realized from its use. In most cases, a decision is reached by estimating the cost of making the parts without a jig, and comparing this with the cost of the jig plus the estimated production cost when the jig is employed. Obviously, any means of lowering the cost of making jigs such as described in the following paragraphs will tend to increase their use.

It is well known that a plate can be quickly laid out and drilled in an upright drilling machine, but it is generally believed that it is almost impossible to produce an accurate jig plate by this method. However, by employing the methods to be described, jigs of the thin templet type can be made very quickly and accurately. Assuming that the problem is to make a templet jig such as shown in the



Templets for locating Holes

upper view of the illustration, the first step is to select the proper size of commercial ground steel or a good grade of cold-drawn flat steel. After this piece has been cut to the required size, it should be made square and flat, one side being milled or ground, if necessary, to produce a flat surface. This flat surface is then polished and coated with a solution of sulphate of copper. The lines are laid out by measuring from a surface plate with a height gage equipped with a scriber. The templet should be clamped to an angle-iron during the measuring and scribing operation.

A small mark with a scratch awl is made at the intersection of the various lay-out lines, care being taken to see that this mark is accurately positioned at the intersecting point. A magnifying glass can be used to advantage when doing this work. Next the marks made with the awl are enlarged with a center-punch. It is a good plan to hold the center-punch as nearly perpendicular as possible, and strike it very light blows with a small hammer. After this operation, an inspection of the punch marks with the aid of a magnifying glass is necessary. If any marks are off center, they may be corrected by inclining the punch in the direction of the error and striking it a few very light blows, and then striking an additional blow or two with the punch in an upright position.

The templet is next spotted with a small combination center drill. It is well to shorten the drill, as there is more danger of its being broken off in the work if it is used full length. Then the holes are drilled through with a drill about 1/64 inch under size, after which a reamer about 0.010 inch under size is used. The templet is next inspected and if the holes are found to be accurately positioned within the required limits, the job is completed by enlarging the holes with a machine reamer of the correct size. In case any of the holes are not correctly positioned, the following method is employed.

Let it be assumed that the hole *A* is found to be off center 0.003 inch. With a small three-cornered file, a very small notch *B* is made in the hole opposite the side that is off center. This notch may be widened just a little with a round file. The reamer will be drawn toward the side in which the notch is filed. Until the workman has had considerable experience, it is best to use an under-size reamer so that a second opportunity may be had to bring the finishing reamer to the exact central position.

A type of templet that can be made rapidly is shown in the lower view. The holes *A* in this templet are required to be located very accurately in relation to the slot *B*. In making templets or jigs of this kind, a slot is first milled, after which a bushing with a hole the same size as that required in the templet is fitted into the slot. The hole in the bushing then serves as a guide for drilling and reaming the plate or templet. The slot locates the bushing laterally, and the required distance between the holes is obtained by measuring from the end of the templet. It is a good plan to have the bushing a tight fit in the slot. If necessary, however, the bushing may be clamped or soldered to the templet while drilling the hole. The two examples here given illustrate principles that may be employed to advantage in making small templets or jigs.

Woonsocket, R. I. S. W. Brown

DRYING INK ON TRACINGS

It has been estimated that about 10 per cent of the time required to ink a drawing or tracing is lost in waiting for the ink to dry. In order to prevent this waste of time in a certain drafting-room, an electric socket was provided for each drawing table and each draftsman given an electric hair-drying apparatus which he could use for drying the inked-in lines. With this drying equipment, the time spent in waiting for the lines to dry was reduced from 10 to 2 or 3 per cent of the total time required for tracing. While this may seem an item of small account in a small drafting-room, it becomes a matter of some importance in plants where a number of draftsmen are employed.

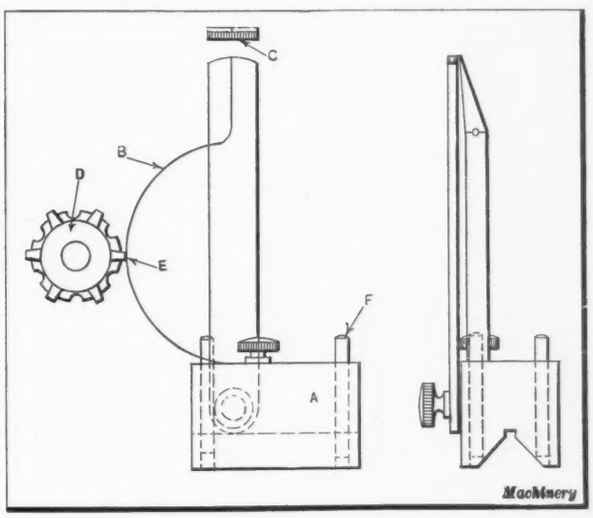
Nijmegen, Holland H. C. Ten Horn

BOW SPRING INDICATOR

Many applications of the comparison method of testing parts have become important factors in maintaining high standards in the manufacture of various products. The bow spring indicator shown in the accompanying illustration has proved to be a convenient device for making comparison tests on certain kinds of work. The base *A* is made sufficiently heavy to provide a firm support for the indicating device.

The bow-shaped spring *B* of the indicator shown is 0.3 inch wide by 0.025 inch thick, and is carefully tempered. The slightest contact of the lower part of the bow spring with the work is indicated by a greatly magnified movement of the pointer on scale *C*. The particular indicator shown is designed primarily for testing the uniformity of the radial setting of the cutting edges of the reamer blades in an inserted-blade type of reamer.

The reamer *D* is mounted between centers and rotated in either direction to bring the successive cutting edges into contact with the spring bow *B* at point *E*. Any variation



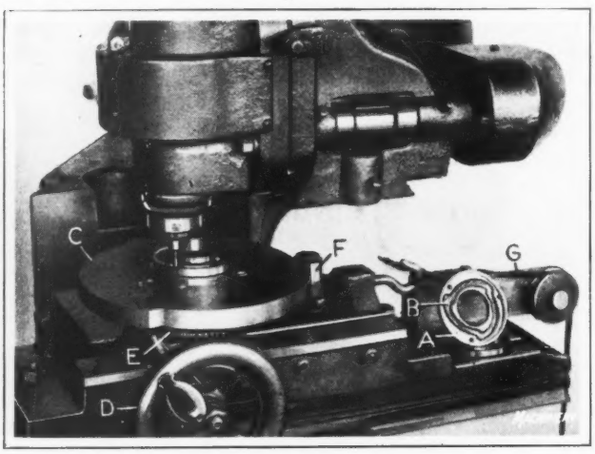
Bow Spring Indicator

of the pointer on scale *C* means that the cutting edges are not located at a uniform distance from the axis of the reamer. Various adaptations of the indicator to lathe work, such as testing the concentricity of a turned piece, the detecting of a taper in a piece that is supposed to be cylindrical, and similar applications, will occur to the user. A V-groove in the base provides a means of applying the indicator to a cylindrical body, and two pins, one of which is shown at *F*, may be pressed down to provide a stop for obtaining a true annular movement around the cylindrical part.

Christchurch W., New Zealand — ANDREW WEBSTER

MILLING ECCENTRIC SLOTS IN A CAM-PLATE

In reading the article entitled "Cutting Eccentric Slots in a Cam-plate" on page 565 of March MACHINERY, the writer was reminded of the special fixture shown in the accompanying illustration, which is used in milling eccentric slots in cam-plates like the one shown at *A*. The depth of the eccentric slot *B* is 1/4 inch, or one-half the thickness of the plate, which is 3 inches in diameter and 1/2 inch thick.



Fixture used in milling Eccentric Cam Slots

As the eccentric slots do not extend through the plate, an end-mill is employed.

As shown in the illustration, the cam-plate is bolted to the center of a master cam-plate *C* which is rotated by turning a handwheel *D*. This handwheel is mounted on the shaft of a worm which meshes with the worm-wheel *E* secured to the under side of plate *C*. In cutting the cam groove, the end-mill is fed slowly down into the work to the required depth, after which the operator revolves the handwheel slowly until the three connecting cam slots are finished. The master cam-plate *C* is kept in contact with the fixed roller *F* by a weight attached to rope *G*. One end of rope *G* is secured to a hook on the slide on which the master cam-plate is mounted.

Cincinnati, Ohio — AVERY E. GRANVILLE

SPRING THREADING-TOOL HOLDER

Having failed to obtain satisfactory results with various spring threading-tool holders, the writer finally designed and constructed the holder illustrated in Fig. 1. The details of the holder are shown in Fig. 2, and are identified by the same reference letters as in Fig. 1. The tool *F* is securely clamped to the machined lug on the end of the

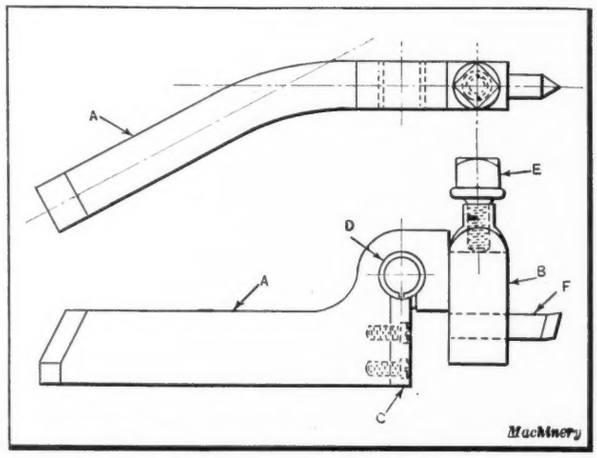


Fig. 1. Spring Holder for Threading Tool

holder *A* by the clamping yoke *B*. The piece *C*, which is secured to the holder by small fillister-head screws, has a slot at its upper end which fits over two small projections at *a* and *b*, Fig. 2. This construction prevents the end of the tool-holder from being sprung sidewise and thus causing an error in the pitch of the thread being cut. The slotted spring bushing *D* can be removed and replaced by a solid piece when the tool is used for roughing cuts.

Philadelphia, Pa. — HUGO LJUNGQUIST

* * *

PORCELAIN

As an insulating material, porcelain occupies a field by itself, and probably more of this material is used yearly than of all the other insulating materials combined, with the exception of rubber. The characteristics that give porcelain its value to the electrical industry may be stated as follows: High insulating value, a vitrified structure which resists the entrance of water or moisture, refractoriness, resistance to oils and vapors, freedom from tendency to warp, weaken or deteriorate in any way with age or severe service conditions, attractive appearance, ease of forming into various intricate shapes which are made permanent by firing, mechanical strength, with the exception of resistance to impact, and comparative cheapness.

* * *

In 1924 Japan imported about one-half the tonnage of German metal-working machinery that was imported in 1913. The idea that Germany is getting an exceptional hold on the Far Eastern market is apparently erroneous.

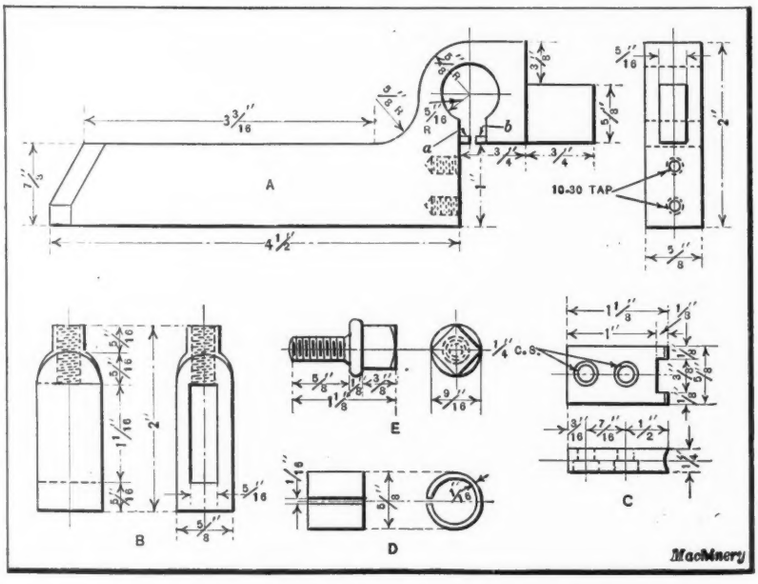
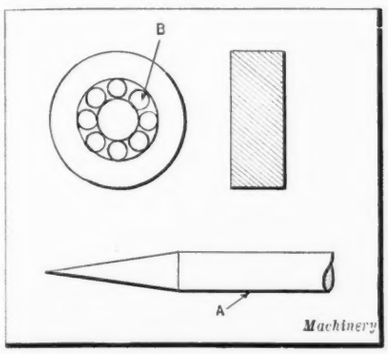


Fig. 2. Details of Spring Threading-tool Holder shown in Fig. 1

Shop and Drafting-room Kinks

ROLLER-BEARING KNURLING TOOL

The high transverse pressure required between hardened knurls and the work to produce good results causes excessive wear on the axis studs and the knurls. As it is cheaper to replace the studs than the knurls, it is the usual practice to make the studs slightly softer than the knurls. In order to eliminate the necessity for frequent renewal of these studs, the writer designed the type of knurl shown in the accompanying illustration. In this design rollers *B* are used for the bearing, and all the members are made equally hard, so that they will stand up under constant and severe usage without necessitating frequent replacement of the parts.



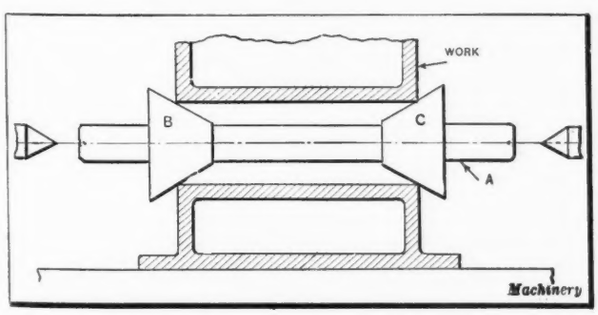
Roller-bearing Knurling Tool

The roller-bearing knurl proved so satisfactory that some of the old type knurls were converted into the roller type by annealing, enlarging the bearing hole, again hardening the knurl, and assembling it with the hardened stud and rollers. The rollers for these knurls were made from 1/8-inch steel rod. In assembling the rollers in the knurls, a coating of vaseline was employed to hold the rollers in place while inserting the axis stud. A conical pointed tool like the one shown at *A* was found very useful in centering or spacing the rollers in the knurl.

Christchurch, W., New Zealand — ANDREW WEBSTER

CENTERING BAR FOR BORING MILL WORK

The centering of work on the boring mill is usually accomplished only after many trial settings and tests have been made, accompanied by the adjusting of the machine bed and the taking of measurements from the tool in the boring-bar. A simpler method, which can be used to advantage on production work, and which will appeal to the operators of boring mills, is shown in the accompanying illustration. A mandrel *A* of any diameter, but somewhat longer than the work, is fitted with two cone collars *B* and *C*. The included angle to which the conical sections of these collars are cut is 60 degrees. The length or depth of the conical sections must be sufficient to accommodate the maximum and minimum sizes of holes to be bored. When the centering bar is employed, the cones are pushed or forced into the bore, thus bringing the work into alignment with the machine spindle, where it can be secured by shifting the bed and using clamps in the usual way.



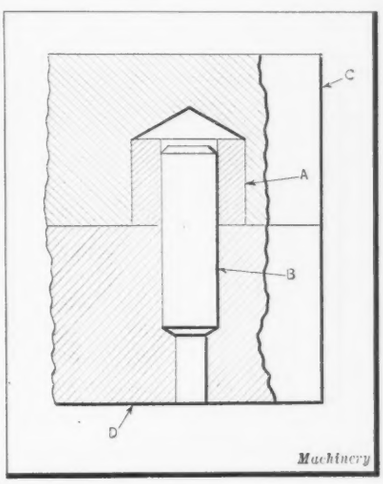
Method of aligning Work on Boring Mill

Washington, D. C. — GEORGE A. LUERS

REMOVING BUSHING FROM BLIND HOLE

The removal of a bushing from a blind hole was recently accomplished by one of the toolmakers in our plant in the following manner: The hardened bushing shown at *A* in the illustration was used in connection with the dowel *B* to obtain accurate alignment of the two members *C* and *D* of the fixture. The design of the fixture is such that the hole in which the bushing was pressed could not be drilled through the member *C*.

After having pressed the bushing in place, the toolmaker had occasion to remove it. On attempting to do this, he found that there was not sufficient space below the inner end of the bushing to permit using a hook or other device commonly used in removing bushings. The drilling of a hole through the member *C* that would permit the use of a punch was out of the question, and the bushing could not be annealed and drilled out without spoiling other parts of the fixture.



Bushing and Pin used to align Two Members of a Fixture

Finally the toolmaker resorted to the use of hydraulic pressure, which was accomplished by pouring a fairly heavy oil into the bushing hole, inserting a snug-fitting plug, and pressing down on the plug with an arbor press. The hydraulic pressure produced caused the bushing to rise a little, after which more oil was added. This was continued until the bushing was forced out.

Newmarket, N. J. — HARRY M. FUNNELL

USING A TWIST DRILL AS A REAMER

Workmen in small shops where a complete line of reamers is not available should remember that it is possible to use a twist drill as a substitute for a reamer. To prepare a twist drill for reaming, the cutting corners and edges should be removed from the end or cutting lips of the drill with an oilstone. If the drill is run at a slow speed and feed, a smooth, accurately sized hole will be produced.

Philadelphia, Pa. — W. H. FLYNN

* * *

The question is often asked, "Can the motor bus handle the transportation of a great metropolis?" Many Americans unfamiliar with the success motor bus transportation has achieved abroad are still doubtful. The latest figures available relating to motor bus transportation in London show that in that city motor buses carried last year 1,158,411,000 passengers, or an average of 3,250,000 a day.

Questions and Answers

GLUE FOR ATTACHING MICA TO STEEL

R. H. C.—The writer has experienced considerable difficulty in obtaining a cement or glue that will cause sheet mica approximately 0.010 to 0.015 inch in thickness to adhere to cold-rolled sheet steel or cast-iron plates. All the common glues, ordinary shellac, and button shellac have been tried without success. Can some reader of MACHINERY give the name or composition of a glue or cement that can be used for this purpose?

CALCULATING DIAMETER OF GAGE-CHECKING DISK

L. R. M.—In making a gage such as shown at A in the accompanying illustration, it was found desirable to check the accuracy of the work by using disk B in the manner indicated. The 0.313-inch radius a is required to be 0.126 inch deep on one side. The problem is to find the radius x of the disk B which will be tangent to the base line, the center line LM, and the radius a. Will some reader of MACHINERY please show how the diameter of disk B can be calculated?

ANSWERED BY R. L. WAKELEE, TOLEDO, OHIO

The solution to this problem given on page 652 of April MACHINERY involved the use of quadratics, whereas only simple arithmetical operations are required in the following solution. Referring to the accompanying diagram, we have given, a = 0.313 inch; b = 0.187 inch; $a + b$ = 0.500 inch. Let $a + b = c$.

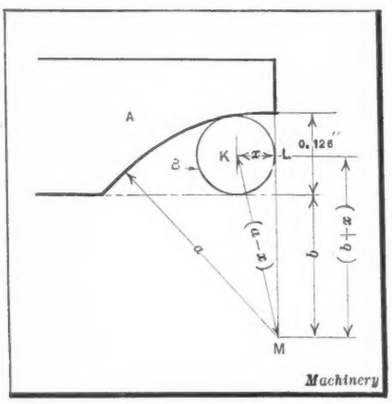


Diagram used in calculating Diameter of Disk

Now in the triangle KLM we have:

$$(b + x)^2 + x^2 = (a - x)^2$$

Expanding,

$$x^2 + 2x\,(a + b) = (a - b)\,(a + b)$$

Now completing the square,

$$x^2 + 2x\,(a + b) + (a + b)^2 = (a - b)\,(a + b) + (a + b)^2$$

Extracting the root,

$$x + a + b = \pm\sqrt{2a\,(a + b)}$$

Solving

$$x = -(a + b) \pm\sqrt{2a\,(a + b)}$$

Substituting c for $a + b$,

$$x = -c \pm\sqrt{2ac}$$

Now substituting numerical values,

$$x = -0.500 \pm\sqrt{2 \times 0.313 \times 0.500}$$

$$= 0.05946 \text{ or } -1.05946$$

Disregarding the negative value, x = 0.05946. Then the diameter of disk $B = 2 \times 0.05946 = 0.11892$ inch.

EFFICIENCY OF SCREWS FOR POWER TRANSMISSION

W. S. J.—What kind of screw thread is preferable for power transmission, and how does the efficiency of a single-threaded screw compare with the multiple-threaded form?

A.—Multiple-threaded screws are ordinarily used for power transmission, as they are much more efficient than single-threaded screws, the efficiency being decidedly affected by the helix angle of the thread. Single-threaded screws are sometimes preferable, owing to their mechanical advantage as compared with the multiple-threaded form. Thus a heavier load can be moved by a single-threaded screw than by the multiple-threaded type, assuming, for example, that the screw diameters and the force applied are the same in each case. The single-threaded screw, in this instance, moves the load only one-half as far as a double-threaded screw, so that it is capable of overcoming greater resistance for a given applied force, although the mechanical efficiency is lower than that of the multiple-threaded screw.

In determining the efficiency of a screw and a nut, the helix angle of the thread and the coefficient of friction are the important factors. If E equals the efficiency, A equals the helix angle, measured from a plane perpendicular to the screw axis, and f equals the coefficient of friction between the screw thread and nut, then the efficiency may be determined by the following formula, which does not take into account any additional frictional losses, such as may occur between a thrust collar and its bearing surfaces:

$$E = \frac{\tan A\,(1 - f \tan A)}{\tan A + f}$$

This formula would be suitable for a screw having ball-bearing thrust collars. Where collar friction should be taken into account, a fair approximation may be obtained by changing the denominator of the foregoing formula to $\tan A + 2f$. Otherwise the formula remains the same.

The square form of thread has been used chiefly for power transmission, because it has a somewhat higher efficiency than threads with sloping sides. However, when the inclination is comparatively small, as in the case of an Acme thread, the preceding formula, which was deduced for a square thread, may be applied without serious errors. The Acme thread has practical advantages in regard to cutting and also in compensating for wear between the screw and the nut. In the use of this formula, it is necessary to assume a value for the coefficient of friction. According to experiments by Professor Kingsbury, a coefficient of 0.1 is about right for pressures less than 3000 pounds per square inch and velocities above 50 feet per minute, assuming that fair lubrication is maintained. If the pressures vary from 3000 to 10,000 pounds per square inch, a value of 0.15 is recommended for low velocities.

As the foregoing formula will show, the efficiency between a screw and nut increases quite rapidly for helix angles up to 10 or 15 degrees (measured from a plane perpendicular to the axis). The efficiency remains nearly constant for angles between 25 and 65 degrees, and the angle of maximum efficiency is between 40 and 50 degrees.

It is evident that the screw of a jack, or of any lifting or hoisting appliance, will not be self-locking if the efficiency exceeds 50 per cent, as higher values would mean that the screw would turn in its nut under the action of the load. In actual designing practice, it will be understood that the maximum efficiency, even for a screw intended solely for power transmission, may not be practicable, as, for example, when it is necessary to employ a helix angle smaller than that representing maximum efficiency, in order to permit moving a given load by the application of a smaller turning moment.

* * *

Australia buys the greatest number of passenger cars from the United States and Japan purchases the biggest number of motor trucks. Last year, 39,564 cars were sold to Australia, and 3503 trucks were taken by the Japanese market.

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, June 16

CONDITIONS in the engineering field are quiet, but there is no lack of confidence in the future, and in several branches there has been greater activity during the last few weeks. The conditions, however, vary considerably in different fields.

The machine tool industry is patchy in every district; firms that are in a position to supply machines required by automobile manufacturers are busy, but the demand for regular lines of machines is inactive. Makers of grinding machines of all types are among those who find business better, and milling machines and turret lathes are in somewhat better demand. Many of the larger machine tool shops, however, are busier than for some time past; but new orders are coming in slowly. The demand for machine tools has not yet spread sufficiently from the special requirements of the automobile industry, and though orders from this source have saved the situation in the cases of many firms, there can be no real satisfaction in future prospects until the basis of orders has extended considerably into the general engineering field.

Overseas Trade in Machine Tools

The rapid advance in the exports of machine tools that occurred during February and March was not maintained during April, the figures for that month having fallen to those recorded for January. The value of exports in April was £143,023 for a tonnage of 1157, these figures comparing unfavorably with those of £173,797 for a tonnage of 1693 in March. The falling off, although substantial, has not seriously disturbed the general slope of the curve for the last twelve months, the tendency being upward. A significant feature of the export figures is the fact that in April the value per ton was £124, which is a considerable increase over the March figure of £103. The exports of machine tools continue to show better progress than the general exports from this country.

The most important item of machine tool exports was lathes, which accounted for a value of £47,882. An important customer for machine tools during March was Poland, nearly £37,000 worth of lathes being shipped to that country during the month. Other important customers were India, with over £25,000 worth of machine tools, New Zealand, £11,000, Australia, £11,000, South Africa, £10,000, Russia, £5500, and France, £5500.

Machine tools imported during April reached a value of £50,785, for a tonnage of 297. These figures were slightly lower than those recorded for March, the figures for the latter month being £60,374 for a tonnage of 350. The value per ton of imports during April was £172. America, during March, sent England machine tools to the value of about £50,000, the nearest other competitor being Germany, who sent tools to the value of nearly £11,000.

General Engineering Field

Although general conditions are quiet, the number of branches in the engineering field in which activity is considerably above the average is growing. For example, structural engineers, heavy engine builders, and light foundries can now be added to the plants making heavy electrical equipment and rolling stock, which for many months past have been conspicuous for their activity in the engineering field. The heavy engineering industry, except when concerned with the branches already referred to, is somewhat depressed, and boiler makers continue to be short of work.

In some directions there are many more inquiries for textile machinery, although the home market is very quiet. Russia, the Balkan States, and Poland are all anxious to purchase British textile machinery, but financial difficulties prevent many orders from materializing. From Germany there is an increased demand for fine spinning machinery, a demand that has shown a tendency to grow in the last three or four months.

Locomotive builders find business somewhat better; among the orders on hand are thirty passenger and freight locomotives for the South Australian Government; the freight locomotives are said to be the largest ever built in this country, the running weight of the engine and tender being over 200 tons. Plants making mining machinery, pumping machinery, industrial electric motors, and cables are among the busiest in the engineering industry. Makers of agricultural machinery, cranes, sugar-making machinery, and hosiery machinery makers are not so well placed as they were a few months ago.

The Automobile Industry

The production of automobiles is now at a peak, and prospects of a continuation of the present phenomenal activity are well established. Home demand for practically all types of cars is particularly good, and the export trade is expanding rapidly. Most manufacturers have large orders in hand for overseas markets, and there is reason to suppose that at the current rate of shipment the number of cars to be exported will reach a record for the season. During the first two months of the year the number of cars exported was more than double that for the corresponding period of 1924, and one well-known maker is stated to have sold more cars abroad in one month than in the whole of last year.

As a direct result of the re-imposition of the 33 1/3 per cent import duty on private cars, some of the large manufacturers in the Midlands are planning bigger production than was originally contemplated. In the case of one large firm, the output of cars will now be double that of last year and four times that of 1923. This will call for a considerable quantity of new machine tools and general equipment.

Shipbuilding

On the Clyde, May brought only a slight improvement in the number of new shipbuilding orders. Considerable relief, however, was experienced as a result of the order for two 10,000-ton cruisers placed by the Australian Government at Clydebank. The total value of the Australian naval orders for cruisers, armament, and submarines placed with British shipyards and armament firms is £3,500,000.

There has been a slight increase in ship repair work on the Northeast Coast, but there is no definite sign of revival in new building; the few new orders barely replace the tonnage launched during the month. On the Mersey, ship repairing orders are more numerous than for the last few months.

* * *

The American Society for Testing Materials held its twenty-eighth annual meeting at the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., June 23 to 26. A great number of papers were presented, in addition to numerous reports. One entire session was devoted to wrought iron, cast iron, and corrosion; another to non-ferrous metals and metallography; and a third to steel and fatigue of metals. Other sessions were devoted to non-metallic materials, including concrete, cement, insulating materials, paints, rubber, etc.

Standardization of Abrasives

By HENRY R. POWER, The Carborundum Co., Niagara Falls, N. Y.

THE manufacturers of electric furnace abrasives have made a valuable contribution to the national program of waste elimination. Long ago the leaders in abrasive engineering appreciated the existence of great waste in industry. The recent report of the Engineering Council stating that these wastes amount to 25 or 30 per cent of the cost paid by the consumer or producer of raw materials, has been anticipated by the Grinding Wheel Manufacturers' Association of the United States and Canada. Waste from lack of standards of quality and waste from unnecessary multiplication of sizes and varieties has been the subject of tedious work of investigation in the industries supplied by the abrasive makers. For several years conferences have been quietly carried on by the technical men of the abrasive industry. Investigations have gradually been made, and the fruit of this labor is now being shared not only by the abrasive industry but by its customers as well.

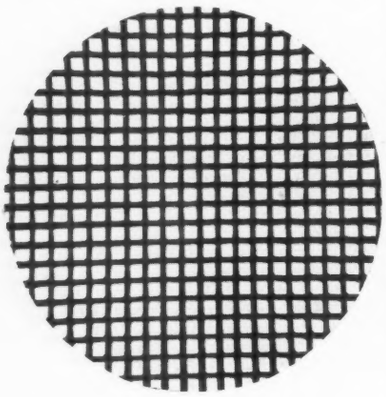


Fig. 1. Section of Bureau of Standards Screen through which Electric Furnace Abrasives are graded

Electric furnace abrasives and the modern grinding machine have done much in developing manufacturing practice, by turning out a vast number of mechanical parts that are duplicates and can easily be interchanged, combining quantity production with extreme accuracy of size. These two factors have contributed greatly to short-cut methods and to the elimination of waste.

The desire to give abrasive users the benefits of standardization and to promote industrial efficiency, has led to simplifications by the abrasive manufacturers. For example, in the making of coated abrasives, such as abrasive paper and cloth (often miscalled "sandpaper"), the sizes of the grits used have been carefully determined; the kinds of "backing," whether twills, jeans, or drills, the weights of paper, whether cylinder or Fourdrinier, the marking of the coated material and the packages in which distribution is made have all been carefully standardized and simplified. The saving to the users of coated abrasives is obvious.

Going further, the making of grinding wheels has been studied, and after five years of labor, the standardization committee of the Grinding Wheel Manufacturers' Association has reduced wheel-face shapes to twelve, and wheel types to fourteen, which would make possible a reduction of present stocks of grinding wheels of 459,400 wheels. The reduction of excessive inventories and the quick turnover resulting from this simplification will save the grinding wheel makers and users thousands of dollars yearly.

No branch of the abrasive industry has been neglected. A survey was made of the most important material used in the industry, namely the abrasives, which constitute 85 per cent of the grinding wheels, and are also sold separately to those who wish to use them in the fabrication of polishing wheels. The sizes of these abrasives were studied; and the methods by which they should be prepared, the laboratory test that should be applied in their commercial preparation, the screens that should be used in checking the sizes were all carefully gone over and standards set so that the product of any manufacturer would be in accordance with that of every other producer of the material. In adopting these standards, attention was paid to the fact that they should be consistent with economy of production and liberal enough for efficient functioning.

First, the number of grades or sizes required by the polishing trades, which use abrasives for set-up wheels, was determined. Nineteen standard grades were adopted by the Grinding Wheel Manufacturers' Association, after a survey of those already in existence and a study of the requirements of the trade. These grades range from No. 10 to No. 220. They are prepared through control screens of a certain aperture size, no attention being paid to "mesh," count, or openings per inch. Thus a No. 100 grit passes a No. 100 screen—not a No. 100-mesh screen. In deciding on nineteen grades, it was thought by the grain makers that a sufficient variety of sizes was introduced to cover all the common polishing operations. In making set-up wheels to grind the wide variety of products in the polishing trade, such as rifle barrels, pistol parts, plows, hoes, axes, hammers, wrenches, etc., there will be found in the standard list one or more sizes adapted for the particular job in hand. The list of numbers follows: (The number 40 placed in parentheses after 46 is sometimes used in the trade to designate No. 46 grit. Similarly, No. 50 is sometimes used instead of No. 54.)

10	24	60	120
12	30	70	150
14	36	80	180
16	46 (40)	90	220
20	54 (50)	100	

In the standardization of each grit size, a control screen has been established on which a maximum over-size is allowed. A second screen has also been selected on which 75 per cent of the grit passing through the control screen must remain. The other 25 per cent may be finer than the second screen. Not only have these screens been established, but carefully graded grits, prepared according to the schedule, are being distributed among producers, against which the commercial product must be carefully checked from time to time. This will compensate for any possible difference in testing screens.

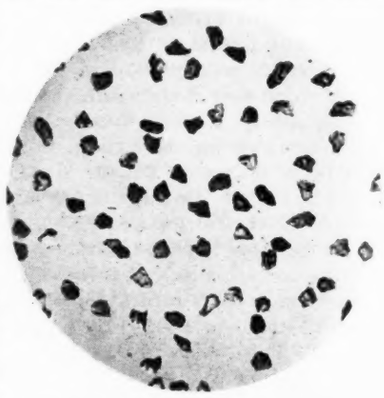


Fig. 2. No. 60 Grit magnified to show Uniformity in Size

The screens used in testing commercial abrasives are the finest product in the art of weaving. They are American-made according to the rigid specifications of the Bureau of Standards. Thus scientific accuracy is brought to the polishing room in the form of accurately graded electric furnace abrasives. These screens are prepared according to a table in which the diameter of the wire, with certain tolerances, is specified as well as the size of opening, for obviously the number of meshes per inch is an inaccurate

measure if the wire diameter varies widely. The size of the opening is in reality the surest gage of accuracy in a sifting screen, and this is affected by the wire diameter.

The Bureau of Standards scale lists screens varying in opening by the $\sqrt[4]{2}$, so that every screen is 1.189 times the size of the preceding one. Thus every second one is in the ratio of $\sqrt{2}$:1, and every fourth screen is 2:1. These specifications are given in the accompanying table.

An illustration of one of these screens showing the uniformity in opening is seen in Fig. 1. It is clear that with such screens only very accurately graded abrasive is possible. Fig. 2 shows the uniformity of size of the No. 60 grit. The degree of accuracy required in sizing abrasives has made it necessary to develop special grading machinery to meet the specifications and the requirements of abrasive users.

U. S. STANDARD SIEVE SERIES

Sieve No.	Sieve Opening, Mm.	Sieve Opening, Inch	Wire Diameter Mm.	Wire Diameter, Inch	Tolerance in Average Opening, Per Cent	Tolerance in Wire Diameter,* Per Cent	Tolerance in Maximum Opening, Per Cent	Mesh per Cm.	Mesh per Inch
2 1/2	8.00	0.315	1.85	0.073	1	5	10	1	2.6
3	6.72	0.265	1.65	0.065	1	5	10	1.2	3.0
3 1/2	5.66	0.223	1.45	0.057	1	5	10	1.4	3.6
4	4.76	0.187	1.27	0.050	1	5	10	1.7	4.2
5	4.00	0.157	1.12	0.044	1	5	10	2	5.0
6	3.36	0.132	1.02	0.040	1	5	10	2.3	5.8
7	2.83	0.111	0.92	0.036	1	5	10	2.7	6.8
8	2.38	0.094	0.84	0.033	2	5	10	3	7.9
10	2.00	0.079	0.76	0.030	2	5	10	3.5	9.2
12	1.68	0.066	0.69	0.027	2	5	10	4	10.8
14	1.41	0.0557	0.61	0.024	2	5	10	5	12.5
16	1.19	0.0468	0.54	0.021	2	5	10	6	14.7
18	1.00	0.0394	0.48	0.0187	2	5	10	7	17.2
20	0.84	0.0331	0.42	0.0165	3	5	25	8	20.2
25	0.71	0.0278	0.37	0.0146	3	5	25	9	23.6
30	0.59	0.0234	0.33	0.0129	3	5	25	11	27.5
35	0.50	0.0197	0.29	0.0113	3	5	25	13	32.3
40	0.42	0.0166	0.25	0.0098	3	5	25	15	37.9
45	0.35	0.0139	0.22	0.0085	3	5	25	18	44.7
50	0.30	0.0117	0.188	0.0074	4	10	40	20	52.4
60	0.25	0.0098	0.162	0.0064	4	10	40	24	61.7
70	0.21	0.0083	0.140	0.0055	4	10	40	29	72.5
80	0.177	0.0070	0.119	0.0047	4	10	40	34	85.5
100	0.149	0.0059	0.102	0.0040	4	10	40	40	101
120	0.125	0.0049	0.086	0.0034	4	10	40	47	120
140	0.105	0.0041	0.074	0.0029	5	15	60	56	143
170	0.088	0.0035	0.063	0.0025	5	15	60	66	167
200	0.074	0.0029	0.053	0.0021	5	15	60	79	200
230	0.062	0.0025	0.046	0.0018	5	15	60	93	233
270	0.053	0.0021	0.041	0.0016	5	15	60	106	270
325	0.044	0.0017	0.036	0.0014	5	15	60	125	323

Machinery

*In order to utilize cloth now on the market, it will be permissible, until notice is given to the contrary, to use wire whose diameter is within a tolerance of 10 per cent for the first three groups and 20 per cent for the last two groups.

In addition to standards for screens and sizing, the manner of laboratory testing, the weight of charge required, and the type of laboratory sifter for checking the grades have been standardized so that every abrasive maker's product is the same in size. The advantages to the polishing trade of these standards is a contribution of the electric furnace abrasive makers. If the polisher extends this standardization to the glue used in setting up wheels and to the methods of handling various operations required in using polishing wheels, he can further benefit both himself as producer and his consuming trade.

* * *

Although conditions in Russia have made business between that country and the United States very difficult, $956,000 worth of American machinery was exported to Russia in 1924. This is in excess of the amount exported in 1910, but not so great as in 1913 or during the war years.

EXPORTING MACHINERY ON CREDIT

A complete treatise relating to the selling of machinery on credit in the foreign market has been prepared by W. H. Rastall, chief of the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce. This review of a subject of great importance to all exporters is published in the June 15 issue of *Commerce Report*, the official publication of the Department of Commerce. In view of much that has been said and printed about foreign credit conditions and the necessity for long terms of credit, Mr. Rastall's article will prove of great value to American manufacturers interested in export trade. Many American machinery manufacturers, accustomed as they are to prompt payment in the domestic market, have been disturbed by the insistent demand that machinery for export be sold on credit. In some cases this has caused several firms to lose interest in the export business, while in other instances it has resulted in the acceptance of export business on terms that were scarcely businesslike. Mr. Rastall's analysis will explain when and how foreign credits should be extended.

* * *

PRIZE FOR FOUNDRY DEVICE

The American Foundrymen's Association has organized a competition for foundry workers for the Syracuse meeting which is to be held October 5 to 9. This competition provides for a prize, known as the S. Obermayer Award, which will be given to the foundryman who submits the best idea for a foundry jig or a device that can be used for the purpose of increasing the production of castings or facilitating the handling of equipment. Any jig, piece of equipment, or description of a method that can be used in molding, making castings, or in handling operations will be acceptable.

A condition is that entries must be in the hands of the judges thirty days in advance of the convention date. Those wishing to compete should, as soon as possible, inform the secretary of the American Foundrymen's Association, 140 S. Dearborn St., Chicago, Ill. This competition is made possible by a fund contributed in 1920 by the S. Obermayer Co. of Chicago.

* * *

SCHOOL OF AERONAUTICS

A School of Aeronautics in the College of Engineering of New York University has been established by a gift of $500,000 by Daniel Guggenheim, the purpose being to bring about more quickly the ultimate possibilities of aerial navigation, and to give to America a place in aerial transportation equal to that of other great nations of the world. In view of the fact that Europe has some 15,000 miles of regularly operated commercial passenger carrying airplane routes, handling, in all, hundreds of thousands of passengers annually, it is evident that the United States has lagged behind in this respect. The Chamber of Commerce of the United States holds that the development of aeronautics in this country is of growing importance for the transportation of valuable commodities, for business mail, for the patrol of forest reserves against the constant menace of fire, and for national defense.

HEAT-TREATMENT OF CARBON AND HIGH-SPEED STEEL

The following recommendations have been issued by the American Society for Steel Treating (4600 Prospect Ave., Cleveland, Ohio) covering the recommended practice adopted by the society for heat-treating plain carbon tool steel. The recommendations cover two different subjects: (1) Normalizing tool steel before hardening; and (2) heat-treating (hardening) plain carbon tool steel.

Normalizing Tool Steel before Hardening

The normalizing operation consists of heating and cooling. To heat, place the steel in a furnace so as to expose the maximum of the surface area to the heat. Heat uniformly to a temperature above the upper critical point, as given in Table 1, and hold the steel at this temperature for sufficient time to obtain complete penetration of the heat and complete refinement of the grain. To cool, remove the steel from the furnace and let it cool in the air. Table 1 gives the temperature to which the furnace should be raised for steel of different carbon contents. Table 2 gives the thickness of the largest section of the steel to be normalized, approximate weight in pounds of the piece of steel, the time required for bringing the steel up to the required temperature, and the time in hours that the steel should be held at this temperature before being removed from the furnace.

Heat-treating or Hardening of Plain Carbon Tool Steel

The operations required for heat-treating or hardening plain carbon tool steel are heating, quenching, and tempering. The heating should be done uniformly to the temperature indicated in Table 3. From this temperature the steel is quenched in water, but should not be permitted to cool down below the temperature of boiling water (212 degrees F.). The steel may be tempered by being reheated immediately in oil, a salt bath ($NaNO_3$), or in a furnace. Tempering temperatures are given in Table 4.

HEAT-TREATMENT FOR PLAIN CARBON TOOL STEEL

Table 1. Normalizing Temperature for Given Carbon Content

Per Cent Carbon	Temperature, Degrees F.	Per Cent Carbon	Temperature, Degrees F.
0.65 to 0.80	1475 to 1525	0.95 to 1.10	1500 to 1575
0.80 to 0.95	1475 to 1500	1.10 to 1.25	1575 to 1650

Table 2. Heating Data for Normalizing Carbon Tool Steel

Thickness of Largest Section, Inches	Weight of Piece, Pounds (Approximate)	Time of Heating, Hours (Approximate)	Time Heat is Held, Hours (Approximate)
Up to 1	Up to 100	3/4	1/2
1 to 2	100 to 300	1 1/4	1/2
2 to 3	300 to 500	1 3/4	3/4
3 to 4	500 to 1000	2 1/4	1
4 to 5	1000 to 1500	2 3/4	1
5 to 8	1500 to 2000	3 1/2	1 1/2

Table 3. Hardening Carbon Tool Steel

Per Cent Carbon	Hardening Temperature, Degrees F.	Quenching Medium	Temperature of Quenching Medium, Degrees F.
0.65 to 0.80	1550 to 1450	Water	70
0.81 to 0.95	1460 to 1410	Water	70
0.96 to 1.10	1390 to 1430	Water	70
1.11 to 1.25	1380 to 1420	Water	70

Table 4. Tempering Carbon Tool Steel

Results Desired	Tempering Medium	Temperature, Degrees F.
Relieving strains	Oil	350 to 375
Relieving strains and reducing brittleness	Oil	400 to 500
Relieving strains and toughening	Oil	500 to 600

Machinery

General Notes about the Processes

The following general remarks are appended to the recommendations made by the American Society for Steel Treating. It is stated that the recommended practice for the heat-treatment of tool steel applies to the highest quality performance of tools for general purposes only. For specific applications, where special requirements seem to be necessary, deviation from the recommended practice must be left to the judgment of the individual heat-treater or metallurgist.

A normalizing treatment for all tool steels is recommended to obtain a uniform and refined grain structure, which enables the operator to predict the behavior and performance of the tool steel during heating and quenching for hardening.

Heating for Quenching—The quenching temperatures given are at the lowest temperature ranges consistent with the highest quality tools; deviations are not recommended, but may be necessary in unusual cases.

Quenching—Water is the universal quenching medium, and by varying its temperature and manner of application for the abstraction of heat, almost any degree of variation of structural conditions of the tool steel can be obtained. There are, however, special cases where oil may be a more suitable quenching medium; judgment and experience are the only guides in cases of this kind.

Carbon Steel Suitable for Various Uses

Steel with a carbon content of from 0.65 to 0.80 per cent is suitable for shear blades, boiler snaps, and cups, hammers, stamping and pressing dies, and mining drills. Steel with a carbon content of from 0.81 to 0.95 per cent is suitable for hot and cold sets, chisels, dies, shear blades, mining drills, blacksmiths' tools, swages, flatteners, and set-hammers.

Steel with a carbon content of from 0.96 to 1.10 per cent is suitable for small cold chisels, hot sets, small shear blades, large pincers, large taps, granite drills, trimming dies, turning tools, planer tools, drills, cutters, slotting and milling tools, mill picks, circular cutters, small shear blades, and threading dies.

Steel with a carbon content of from 1.11 to 1.25 per cent is suitable for small milling cutters, small taps, drills, slotting and planing tools, wood-cutting tools, turning tools, and razors.

Drawing Temperatures for Tempering Various Tools

Temperatures of from 350 to 390 degrees F. are suitable for lathe tools for brass and copper alloys; milling cutters for brass and copper alloys; scraper and cutting tools for soft metals and micarta; drawing mandrels, drawing dies, bone-cutting tools, hammer faces, steel engraving tools, wood-carving tools, cutting tools for iron and steel, hand tools, and threading dies for brass.

Temperatures of from 400 to 500 degrees F. are suitable for hand taps and dies, hand reamers, drills, bits, cutting dies, penknives, milling cutters, chasers, inserted sawteeth, press dies for sheet steel, rock drills, taps and dies, wire-drawing dies, dental and surgical instruments, and twist drills.

Temperatures of from 500 to 600 degrees F. are suitable for bending and forming dies, shear blades, chuck jaws, forging dies, drifts, gages, press dies, flat drills, reamers, chisels and tools for wood-cutting, hammers and drop dies, axes, lathe tools for copper, augers, cold chisels, coppersmith tools, grinders, screwdrivers, molding and planing tools, hacksaws, needles, butcher knives, and saws.

Heat-treatment of High-speed Steel

The following directions are given for different processes in the heat-treatment of 18 per cent tungsten high-speed steel:

Heating for Annealing—Heat slowly and uniformly to a temperature of 1600 degrees F., and hold at that temperature to obtain uniformity of internal condition and grain.

Cooling—Cool in a furnace or in infusorial earth, mica, lime, or any medium that will permit slow, uniform cooling.

Heating for Hardening—(a) Preheating: Heat slowly and uniformly to 1500 degrees F. in a furnace of sufficient size. (b) Heating for Quenching: Transfer the preheated steel to a high-temperature furnace which is maintained at a temperature of from 2250 to 2400 degrees F., depending upon the type of tools being hardened.

In order to obtain the most satisfactory "red hardness" conditions, the steel should be brought rapidly to the higher temperature; but in many cases the character of the cutting edges of certain form tools, such as milling cutters, threading tools, etc., makes it inadvisable to use the higher temperatures because of the danger of destroying the delicate edges through blistering, pitting, etc. It is therefore usual to employ the higher temperatures for such tools as rough lathe tools, while the finer class of tools is hardened at the lower temperatures.

High-speed steel tools should not be held at the high heat longer than necessary, since holding at the high hardening temperatures causes excessive grain growth, with subsequent brittleness of the hardened tools. Tools that cannot be ground after hardening are often heated in a barium chloride or some similar salt bath.

Quenching—Quench the steel in oil or air from the hardening temperature. It is advisable to maintain the oil quenching bath at a temperature of 150 to 200 degrees F. to eliminate possibility of breakage with intricately shaped tools.

Tempering for Secondary Hardness—Reheat the steel uniformly in an open furnace or in a lead bath, or preferably in a sodium nitrate ($NaNO_3$) bath, or in any other suitable salt bath, to a temperature of from 1050 to 1150 degrees F. for a sufficient length of time, and cool in air.

The following notes about the processes are also appended:

Cooling from Annealing—Cooling in air should not be permitted, since air cooling from the annealing temperature is likely to result in partial hardening of the tool.

Heating for Hardening—It is the customary practice always to preheat for hardening in an open furnace, since preheating in a salt bath causes the salt to adhere to the tool, and the subsequent high temperature treatment causes unusual corroding from the adhering salt. Even preheating in lead is objectionable from small quantities of adhering lead. There is not much advantage to be gained in using a molten bath for the preheating, since the preheating temperature may vary over the comparatively wide range of 1400 to 1600 degrees F., and an open furnace is invariably used in practice.

Quenching from Tempering Temperatures—Quenching from the tempering temperatures is not advisable with high-speed steel.

* * *

The Department of Commerce announces that May shipments of railroad locomotives, from the principal manufacturing plants, based on reports received from the individual establishments, totaled 96 locomotives, as compared with 92 in April, and 111 in May, 1924. The total number of locomotives built in the first five months of this year totaled 472, compared with 566 in the same period last year, and 1173 in the first five months of 1923.

Of the locomotives built so far this year, 111 were for export, compared with 43 last year, and 62 in 1923. Unfilled orders for locomotives on June 1, totaled 467, compared with 143 last year, and 2150 the year before. Of those on order on the first of June, 114 were for export.

NORTON AWARDED SCOTT MEDAL

At the commencement exercises of the University of Pennsylvania on June 17, Charles H. Norton, consulting engineer of the Norton Co., Worcester, Mass., was awarded the John Scott Medal for "the invention of accurate grinding devices of high power." The ceremony of presenting this medal to Mr. Norton marked the recognition of his inventions in the grinding machinery field which have contributed greatly to the development of machine shop practice in the last twenty-five years. Mr. Norton's inventions, considered in the award of this medal, include the shape of the table, the mounting of the headstock and footstock, the mounting of the wheel-slide and feed-screw, the construction of a wheel-slide without an adjustable gib, micrometer cross-feed for the wheel-slide, and the "arc-of-a-circle" steadyrest shoe. In addition, Mr. Norton has originated and designed many special machines and attachments, including a locomotive piston grinder, a car wheel grinder, a car axle grinder, a crankshaft grinder, a camshaft grinder, and a heavy roll grinder.

Charles H. Norton

About 1900 when Mr. Norton saw the possibilities of the grinding machine, he suggested the use of high-powered lathes to take heavy roughing cuts preceding the grinding operation, thereby coordinating the processes of turning and grinding in the machine shop and thus reducing cost and increasing accuracy in finishing cylindrical work.

* * *

THE IRON AND STEEL INDUSTRY

The steel mills are operating at about 70 per cent of capacity, having maintained this level of activity for the past month. This is taken as a sign that stabilization has been reached in the industry and that there will be no abrupt change in the near future. There has been a similar stabilization in prices and no further decline is expected. With most steel companies, the business booked in May ran ahead of that of April. Demands for prompt shipment predominate in the market. Steel men feel that the low point in the industry has been reached and that a gradual improvement may be expected from now on. Pig iron production fell off materially in May, as compared with March and April, but it is likely that the lowest point has been reached and that a steady production will be a feature of the pig iron field as well.

* * *

The United States Geological Survey has made an analysis of the state registrations of motor vehicles in the United States, with a view to determining the center of motor vehicle ownership, in the same way as the center of population is located by the Bureau of Census. The center of motor vehicle ownership was found to be located close to Peoria, Ill. This analysis was made in connection with an investigation on the subject of the distribution of energy resources and the centers of production of power in the United States. The center of electric power generation was found to be about fifty miles southeast of Chicago.

The Machine-building Industries

THE general tone in industry is more optimistic at the present time than it has been for some months. Production in the basic industries and factory employment continue at approximately the same level as during the last two months. The distribution of commodities is maintained at a higher level than a year ago. There has been a decrease in the production of iron and steel, but this, in turn, has been offset, as far as general industrial employment is concerned, by the activity in the automobile industry, which in the last three months has reached the highest peak ever recorded. The building contracts awarded during April (the last month for which complete statistics are available) were the largest on record. Prices are firm, encouraging buyers to enter the markets. There is every indication that the forecast of the Harvard Economic Service is correct in its statement that the outlook for the second half of 1925 is for a large volume of business with stable, or possibly rising, commodity prices. Production has been curtailed, and since consumption is large, while inventories are smaller than a year ago, buying should increase.

The Machine Tool Industry

During the last six weeks there has been a gradual resumption of activity in many machine tool building plants, the demand for special machinery or for standard machines with special tooling equipment having increased to a marked degree; but there appears to be no change in the situation in regard to strictly standard machine tools. Some of the leading dealers state that they consider the machine tool business as good as warranted by the present industrial situation, which was outlined in greater detail in this review in April MACHINERY.

Many manufacturers have disposed of the big stocks of standard machines they had on hand, and are more and more inclined to build special equipment to their customers' order. A number of machine tool builders have also engaged in the building of machinery outside of the metal-working equipment field, with a view to reducing the over-capacity of their shops. Thus we find machine tool builders successfully engaged in the making of domestic washing machines, ice cream machinery, woodworking machinery, and automobile clutches. In some cases, these additional lines are marketed directly by the machine tool builder, but generally the machines are built to the order of an outside customer who has his own selling organization.

As might be expected, the demand for special machine tool equipment comes largely from the automotive field. At least two large automobile builders are planning additions to their plants, and one tractor builder has plans under way for the installation of additional equipment. Only the best high-productive machinery, however, is in demand. The automotive industry has developed its cost systems to a high degree of perfection, and whenever new equipment is bought, the resulting savings are carefully calculated. It appears to be a general rule in this industry to buy new equipment only when it will pay for itself within a year. This may seem like an extreme requirement and like asking an exorbitant return on the money invested; but on the other hand, the peculiar conditions surrounding the automobile industry, with its keen competition and constant new developments, make investments that are expected to be amortized over a period of years very precarious. What seem like extreme demands are merely evidences of caution on the part of an industry that has learned some severe lessons.

There has been a fair amount of machine tool buying on the part of some of the railroads, particularly those in the Middle West, but the expected volume of railroad buying has not materialized, and the large lists worked up by the mechanical departments have, in general, been considerably reduced by the time the final orders are placed.

Machine Tool Exports

The export business in machine tools has shown a marked improvement in the case of production equipment. European automobile builders are among the leading buyers, and numerous orders and inquiries have been received from them. Apparently the builders of automobiles in Europe are investigating to determine whether the high-production machinery supplied to American automobile plants would not also be applicable to European conditions. Some machine tool builders state that both the domestic and foreign business is at present better than at any time since 1920, but this must not be understood to mean that the machine tool industry is working to anywhere nearly its capacity. The statement is merely comparative; the business of the last four years with most machine tool builders has been extremely quiet.

The Small Tool Industry

The demand for small tools has been normal during the last two months. Special tools, jigs, and fixtures, especially in the Detroit and Cleveland districts, have been in good demand, but everywhere the makers of both standard and special tools complain that while the volume of business is good, prices are so low that it is difficult to meet expenses. Quite a number of the small tool and special tool shops are running to capacity—a condition that has not existed for several years. It should be noted that this condition exists in the automobile manufacturing district especially, and that a falling off in the automobile business in the autumn will very likely affect the activity in the small tool field in this territory.

Owing to the policy of "hand-to-mouth" buying, a curious condition exists in the small tool branch of the industry. There are many plants that are not occupied to capacity, and yet they run over-time, and sometimes employ a night force in order to meet the insistent demands for quick delivery.

The gear industry has been satisfactorily employed for the last two months, both the plants manufacturing for the automotive industry and the jobbing gear shops having generally been very active. In some localities, the gear shops have been busier than other metal-working plants, and over-time and night shifts have been resorted to in several instances.

The Automobile Industry

The production of automobiles in May reached a total of 404,300 cars and trucks, which was within 4 per cent of the high record for all time established in April this year, and 33 per cent ahead of the production of May last year. A gradual slowing down of this extremely high production has taken place during the month of June, as the seasonal demand has now passed its peak; but when the figures for June are available, it is not likely that they will show a very heavy curtailment. Competition is likely to be keen during the remainder of the year, with the announcement of new models. So far, no radically new designs have appeared, but improvements and refinements are the order of the day. The export trade continues to be heavy, and is now reaching nearly 30,000 cars and trucks a month, being almost 8 per cent of the total production.

The concentration of automobile production in the hands of a comparatively small number of strong, progressive and capably managed concerns seems inevitable, and present tendencies are in that direction.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Heald Semi-automatic Size-indicating Internal Grinding Machine

THE Heald Machine Co., 16 New Bond St., Worcester, Mass., has brought out a new internal grinding machine designed particularly for high production on duplicate work. The interesting features of this machine include a dial type of size-indicating device, and automatic control for various important movements. After the work is chucked and the machine started, the wheel-head advances rapidly to the work, and then automatically slows down to the rate of travel required for grinding. The wheel grinds on the far side of the hole so that the operator has a clear view of the work.

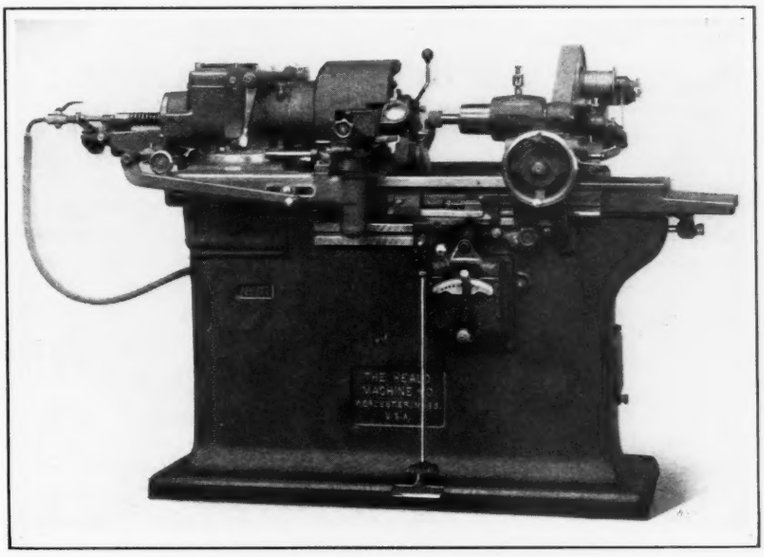


Fig. 1. Heald Size-indicating Internal Grinding Machine

With the coarse feed, the wheel roughs the hole to approximately the finish size as shown by the indicator, which is located in a convenient position in front of the operator (see Fig. 1); then the operator lifts a latch controlling a dog that short-strokes the table just enough to allow the wheel-truing diamond to drop into place, truing the wheel as it re-enters the hole. This provides a true, clean, sharp wheel, which together with an automatic change to fine feed, gives a true hole. Upon reaching finish size, the operator steps on the treadle, seen at the front of the machine in Fig. 1, and the wheel-head withdraws at full speed to the rest position. The work and water automatically stop, and the wheel is automatically guarded.

The sizing control unit, which is securely bolted to the bridge of the machine, has a diamond pointed finger which is in contact with the hole in the work at all times when grinding, but which automatically swings out of the way as the table withdraws to the rest position, allowing for quick removal and chucking of the work. The position of this sizing unit can be adjusted for various sizes of holes. It can be swung out of the way also, when the operator desires to true up a new wheel or grind a "master hole."

The work-head consists of a heavy casting mounted on a rigid bridge which, in turn, is securely bolted directly to the base. The work-spindle is of high-carbon steel with a large-diameter flange which assists materially in lining up chucks or holding fixtures. The spindle runs in large, self-adjusting, radial ball bearings. Provision is made through the work-spindle for a collet-operating tube, which can be adapted to operate draw-in collets or special holding fixtures either of draw-back or push-forward types.

A lever engaging a cone type clutch on the inside of the spindle-driving pulley starts and stops the work and water supply instantly and at the same time. A large supply of water is carried through the spindle and flows over and passes completely through the work, thus assuring even temperature at all times. All loading of the work is done from the front, where loading is most convenient. An extra large aluminum work guard with a spring hinge can easily be swung open when it is necessary to get at the chuck or work.

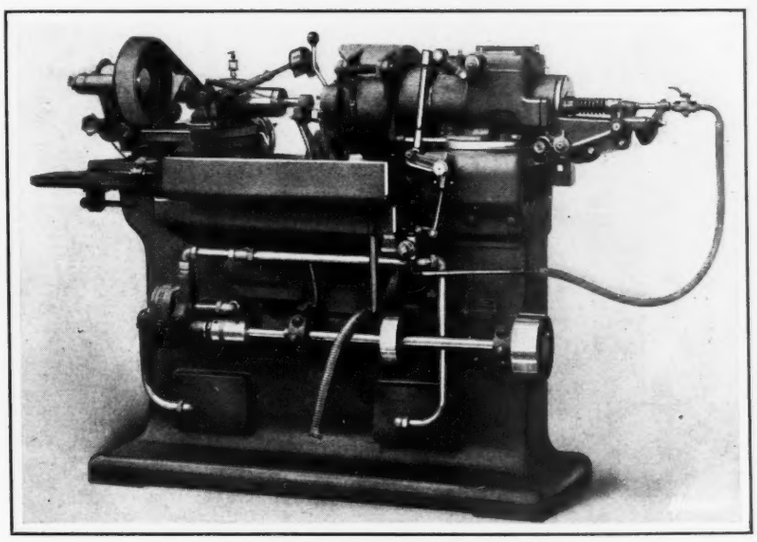


Fig. 2. Rear View of Heald Internal Grinding Machine

There are five changes of work speed covering a range that will take care of all conditions. A coarse feed for the wheel can be set for rough-grinding up to within a desired limit of the finish size of hole, when the roughing feed automatically changes to a finishing feed. The change is mechanical and positive, taking place just before the diamond trues the

wheel. This automatic change of feed, in unison with the truing of the wheel, is an important factor in obtaining a straight round hole without "bell-mouth"; it is also a big element in production, since heavy roughing cuts can be taken without fear of over-size.

In truing a new wheel, the operator must necessarily run the cross-slide back to get position; also, it is desirable to have a maximum size wheel for the hole. To assist him, the cross-slide is arranged with a simple, convenient stop which indicates to the operator that he has trued the wheel down to the largest size possible to enter the hole, and also gives him the correct position of the cross-slide relative to the work so that he can start in grinding immediately.

A cam on the table controls the operation of the wheel-truing device so that it can only be brought down into position at the proper time for dressing the wheel just before finishing a hole to size. After the wheel has been trued, the diamond is automatically raised out of the way. The wheel-truing device is rigidly constructed, positive in operation, easily adjusted for position, and so located that it is back out of the way at all times when grinding, making it possible to use a spindle exactly the right size and length for clearing the diamond.

The main table, which is of rugged construction, travels on a flat and V-way and is of sufficient length to protect the ways from all grit and dirt, regardless of its position. The table is driven by a simple hydraulic arrangement operated by oil under constant pressure, allowing for complete control of speeds or direction of movement at all times. The change of speed is obtained by a throttle control of the oil supply, giving the operator an unlimited number of speeds up to the maximum. Reversal is accomplished at any point of travel by moving a ball-handle lever in the direction in which movement is desired.

The stroke of the table is controlled by three adjustable dogs, two of which are set for the grinding stroke. The third, a sliding member, allows the table to withdraw sufficiently so that the wheel will pass the diamond during the truing position, after which it returns to the grinding stroke. A fine adjustment of the dogs can be obtained by turning worms along a rack. Provision is also made for quick rough adjustment by withdrawing the worms from the rack so they are free to slide to the desired position.

Wheel-heads of various sizes can be furnished, enabling the operator to have the proper size spindle for each particular job. This is essential since the success of mass production largely depends on the wheel-head. These wheel-heads are quickly interchangeable, having the correct size of driving pulley to give the proper speed. A flexible idler mounted on ball bearings and arranged with a spring belt-tightener assures 70 per cent belt wrap. Owing to the constant tension on the belt, there is practically no slippage, which insures a correct and steady wheel speed under any load. A convenient horizontal adjustment takes care of belt stretch and assists materially when installing new belts. A wheel guard covers the wheel almost the instant the wheel leaves the work, swinging in a downward arc. This guard can be adjusted for various lengths of spindles, and it fully protects the operator and does not interfere with holding fixtures or the work-head guard.

The base is heavily ribbed, and the metal is properly distributed to eliminate strains and vibrations. The oil reservoir is completely enclosed in the lower part of the base, so that there is no chance for dirt or foreign substances to get into the oil. At the same time, its weight adds to the rigidity of the machine. The rear shaft, which drives the oil- and water-pump, is mounted on ball bearings. The pump, also completely equipped with ball bearings, is of gear type designed for high-pressure duty. Practically all the piping for conducting the oil is in plain sight and readily accessible. The material is brass tubing with cinch union fittings.

This machine will swing 15 inches, and grind a hole 6 inches in diameter by 6 inches deep. The swing inside the standard water guard is 12 inches. The hole through the spindle for water or holding fixtures is 1 1/4 inches in diameter. There are five speeds for the work, namely 119, 175, 312, 350 and 475 revolutions per minute. Table speeds are unlimited between 0 and 50 feet per minute. The floor space required is 50 by 96 inches, and the weight of the machine, complete, is 5500 pounds.

PRATT & WHITNEY BORING AND REAMING MACHINE

The Pratt & Whitney Co. of Hartford, Conn., has recently developed a special single-purpose machine for boring and reaming the three holes that carry the pinions in automobile differential housings. This machine is suitable for housings of several sizes, and provides means of obtaining rapid production on this operation. It was designed especially for the International Motor Co., New Brunswick, N. J.

In general, the machine consists of a large, angular bed upon which are mounted two separate boring head units each having its own motor drive. These two units are mounted at an angle of 120 degrees to each other, with the work-indexing fixture at the apex of the angle. With this arrangement, the machine maintains the correct boring

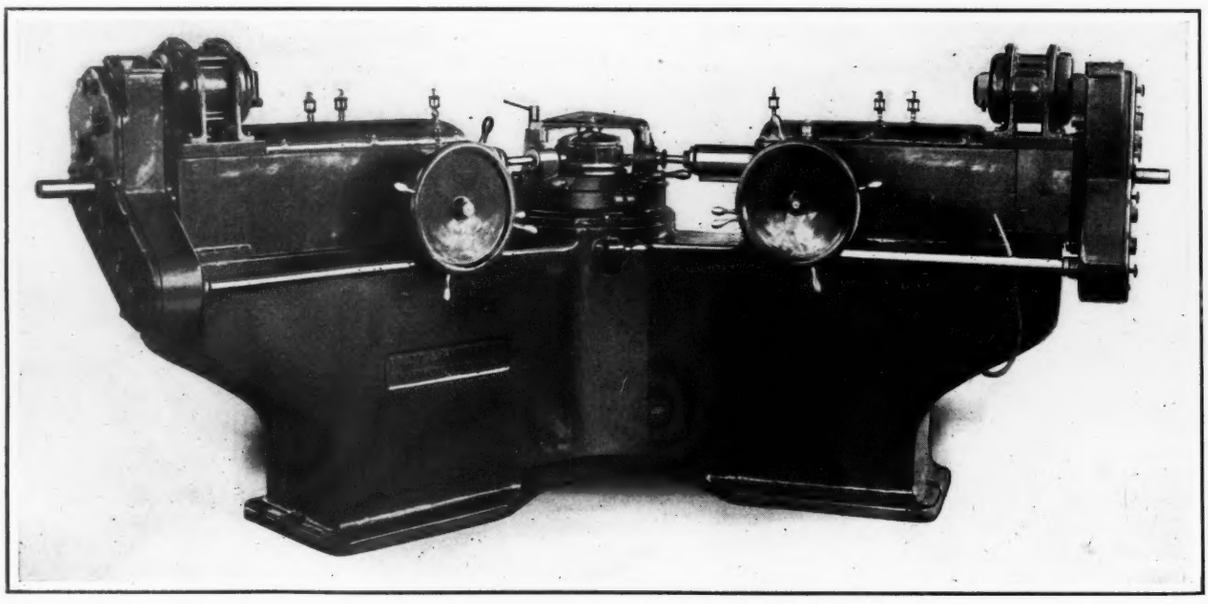


Fig. 1. Pratt & Whitney Special Differential Housing Boring and Reaming Machine

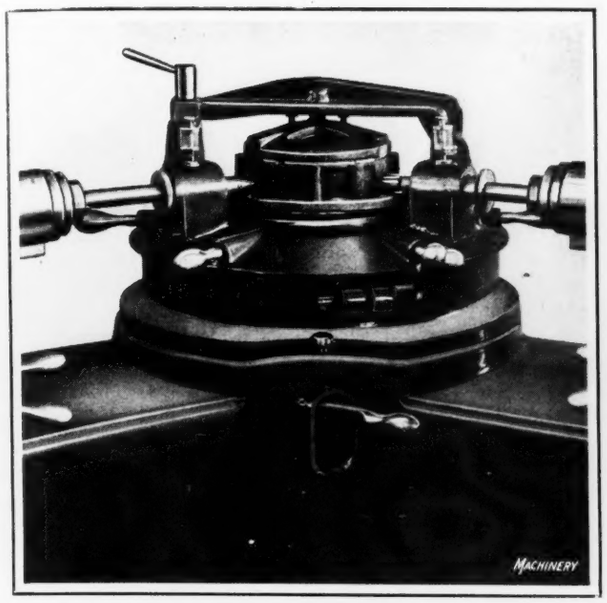


Fig. 2. Indexing Table with Differential Housing in Position

Fig. 3. Work-holding Clamp raised for inserting or removing Work

angle between the two spindles, and the operation is a continuous one, as one spindle is boring while the other is reaming. The bed of the machine is particularly massive to avoid vibration, and forms a rigid foundation so that the machine will do the very accurate work required for these gear mountings.

Fig. 1 shows a front view of the machine, and gives an adequate idea of the general construction. The two heads are practically identical except that they are left-hand and right-hand, respectively. A long spindle quill is mounted in heavy bearings, and a rack on the under side of the quill engages a handwheel pinion for moving the spindle quill by hand. A 1 1/2 horsepower motor running at 1150 revolutions per minute, is mounted on top of each head, and is geared directly to the spindle and to the power feed driving shaft. The power feed is connected to the spindle through a Johnson friction clutch operated by a convenient lever just behind the large handwheel. The boring-bar, driven by the left-hand head, is mounted in the usual manner in the spindle nose, which has a No. 4 Morse taper. The entire mechanism is a particularly rigid one, and is as simple as possible.

The two heads are geared differently, as the left-hand one is used for boring and the right-hand one for reaming. The left-hand head is geared to give a boring speed of 350 revolutions per minute with a power feed of 0.010 inch per revolution of the spindle. The right-hand head has a reaming speed of 150 revolutions per minute with a feed of 0.060 inch per revolution of the spindle. These speeds and feeds can be altered if desired by substituting different gears in the two gear-boxes. The oiling of the heads is accomplished entirely through sight-feed oil-cups, with the exception of the gear-boxes, which are lubricated from a large reservoir in the top of each.

Figs. 2 and 3 show two views of the indexing fixture which holds the work. The work casting is held in place by an over-arm which clamps down on top with a convenient binder. This is shown in the open position in Fig. 3. The three hardened steel shoes which show on the under side of the holding plate are removable, and various sets are provided for the different sizes of castings to be bored. These shoes and the adapter plates are the only parts that need to be changed to accommodate different sizes of work.

The table is indexed by hand, and is provided with a locating pin operated by a lever that projects through the bed. A binder which consists of a split sleeve extending all the way around the table holds the latter tightly in position during boring. This binder has a taper inside surface which forces the table down tightly against the bed, insuring the work being held accurately in place against the locating surface. Floating bushings on the boring and reaming bars fit into the guide holes on the table and form supports for the bars. The same holes also provide means for locating the work by using the taper locating pin shown in Fig. 3. This pin is tapered to accommodate holes from 3/4 inch to 1 1/8 inches in diameter, which is the range of sizes for which the present machine is made. This method of locating the work, by means of the upper and lower machined surfaces and the previously drilled holes is simple and rapid. The table-indexing ways are lubricated by rolls and reservoirs in the same manner that a planer table is lubricated.

CARBORUNDUM PORTABLE SANDING MACHINE

A portable sanding machine designed especially for such work as finishing automobile bodies, metal furniture, railroad car metal work, metal doors and trim, the bodies and doors of safes, the finishing of die-blocks, and many other products has been brought out by the Carborundum Co., Niagara Falls, N. Y. This machine is provided with a special abrasive disk driven by a motor through a flexible shaft. It is so constructed that it is possible for the operator to reach work from almost any angle, and the abrasive disk is flexible so that it will finish, uniformly, concave and convex, as well as flat surfaces. The disk may be applied to either wide or narrow surfaces, sharp curves, various contours, as well as bead and molding work.

The motor is mounted on a rigid cast-iron pedestal, 24 inches high (see Fig. 1), which supports a swivel table to allow the motor to swing through an arc of 180 degrees. This feature greatly facilitates placing the grinding head in any required position. The pedestal is supported by four substantial double casters, permitting ease of movement without danger of upsetting. A holder mounted on the table provides a resting place for the machine head when not in use.

Each machine is equipped with a one-horsepower motor, selected to meet the power conditions of the user. The flexible shaft connecting the motor and grinding head is especially adapted for heavy-duty service. The main castings for the grinding head are aluminum, insuring lightness as well as ample strength and durability. The assembly shafts and spindles are of steel, supported in ball bearings to reduce friction to a minimum. The angular drive from the

Fig. 1. Carborundum Portable Sanding Machine

flexible shaft is through heat-treated steel miter gears running in an oil-tight chamber packed with grease.

The disks used with this sanding machine are the result of considerable research under working conditions. These disks are coated with aloxite, the grains being uniformly graded and applied to the disks so as to allow a free cutting action. The abrasive is on a strong durable backing of cloth drills. This cloth-backed disk is fastened to a special fiber board disk having a molded countersunk center in which there are six pin-holes engaging pins in a special nut that holds the disk securely to the sanding machine head. These disk are furnished in a standard diameter of 9 1/4 inches.

Flexibility is an important feature of the grinding disk, which is supported by a carborundum flexible and compressible pad which yields under pressure, thus allowing the disk to conform to the shape of the work. Hence, the disk adapts itself readily to molding, sharp curves, etc., even with but light pressure. It is claimed that these aloxite disks, despite their flexibility, will not crack, split, or shed abrasive grains. They are supplied in various grit numbers depending upon the finish required and the nature of the work. Fig. 2 shows how this sanding machine is utilized for finishing a die-block.

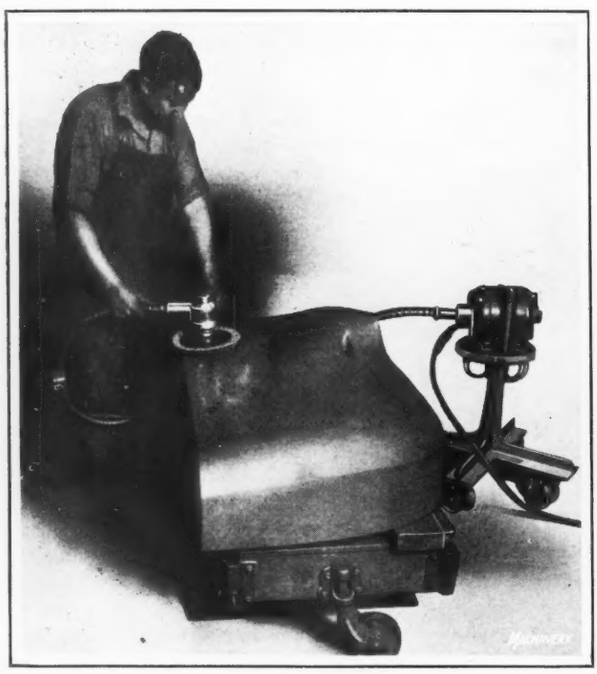


Fig. 2. Finishing a Die-block with a Carborundum Portable Sanding Machine

LANDIS SINGLE-HEAD THREADING MACHINE

A newly designed 1/2-inch single-head threading machine has been placed on the market by the Landis Machine Co., Inc., Waynesboro, Pa. This machine is equipped with a geared headstock and a single-pulley drive, the pulley being mounted on top of the machine. There are four speeds of 157, 226, 315, and 441 revolutions per minute, respectively, for the die-head. Opening and closing of the die-head are accomplished automatically at predetermined limits by the carriage, or by hand. There is a horizontal sidewise adjustment for the vise, as well as a vertical centering adjustment, to insure alignment with the die.

Landis Single-head Threading Machine

A full supply of cooling lubricant is maintained at the die-head by a rotary pump, and there is a special control valve to permit shutting off the oil supply from the head when desired. The frame is cast in one piece with a fluid-tight bottom. The machine may be readily equipped with a motor drive, in which case the power is transmitted by means of a belt from the motor shaft to the drive shaft of the machine. The motor is mounted on a plate on top of the headstock so as to economize in floor space and to prevent oil and dirt from accumulating on the motor parts. The machine employs the Landis all-steel rotary die-head and "Long-life" chasers. The weight is about 950 pounds.

CINCINNATI RAILROAD SHAPER

A 32-inch machine intended principally for railroad work has just been added to the line of "Climax" shapers built by the Cincinnati Shaper Co., Elam St. and Garrard Ave., Cincinnati, Ohio. This shaper is arranged for completely machining locomotive driving-boxes and their accompanying shoes and wedges, driving-box crown brasses, and rod brasses. All the characteristics of the 32-inch heavy-duty "Climax" shaper described in December, 1923, MACHINERY are embodied in this machine, and, in addition, there are special features which make the machine capable of handling the largest driving-boxes used on locomotives. The machine

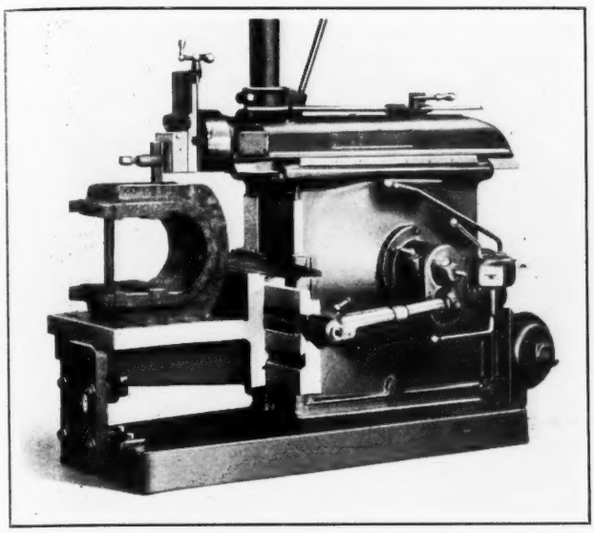


Fig. 1. Cincinnati "Climax" Shaper arranged primarily for Railroad Work

is equipped with a special table; an extended circular feeding head, as well as the standard head; a special shoe and wedge chuck; a standard vise; a 1000-pound boom crane; and an indexing fixture for planing driving-rod brasses. A power-driven rotating fixture can also be supplied for use in handling crown brasses, and the machine may be arranged for either a belt or motor drive.

The special table is constructed with a removable top, 9 1/2 inches deep, which provides a wide range of distances between the ram and the work surface of the table. This top is left in place, as shown in Fig. 2, for planing the crown brass fit in a driving-box, planing the shoes and wedges, and for doing the usual run of shaper work with or without the standard vise. The table top is removed, as illustrated in Fig. 1, for planing the shoe and wedge fits in the driving-boxes. It thus provides sufficient height between the table and the ram to permit placing the largest driving-boxes directly on the table.

The work surface of the upper table is 32 by 24 inches, and that of the lower table, 24 3/4 by 24 inches. Both tables are provided with T-slots, and the upper table with holes into which stop-pins may be inserted. The outer support for the table is effective at all heights, whether the removable top is in place or not, and at no time does any part of it project above the surface on which the work is placed.

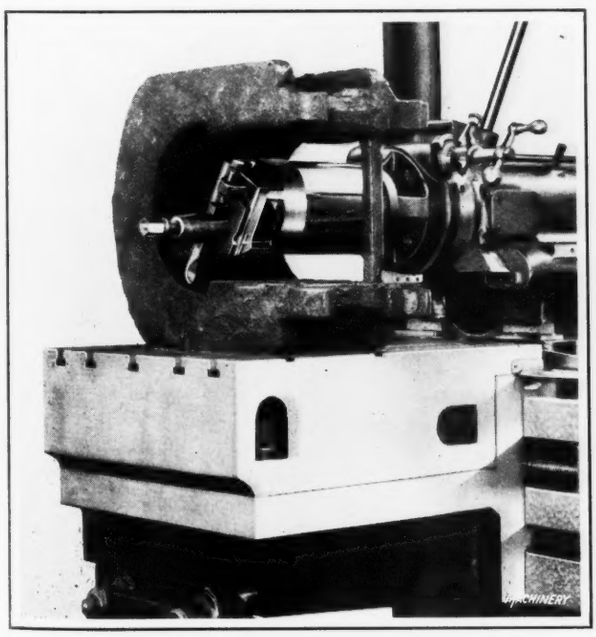


Fig. 2. Planing the Crown Brass Fit in a Driving-box

The circular feeding head shown in Fig. 2 is used in planing the crown brass fit in driving-boxes. These fits may range from 8 to 18 inches in diameter. The extended body is bolted to the end of the ram by four bolts, and it can be rotated either by hand or automatically, similar to the operation of the down feed on the standard shaper. This head is furnished in addition to the standard head, and interchanges with it on the ram.

The special shoe and wedge chuck, shown in Fig. 3, is arranged to handle large and small shoes and wedges, and is made in two parts which can be adjusted along the table to suit the work. Because of this construction, the operator can set his surface gage directly on the table in lining up with lay-out or punch marks. The work rests on four screws which can be easily adjusted for obtaining alignment, and it is held down by eight screws which contact with the sides of the work at an angle. An end-stop bar on the front half of the chuck permits heavy cuts to be taken.

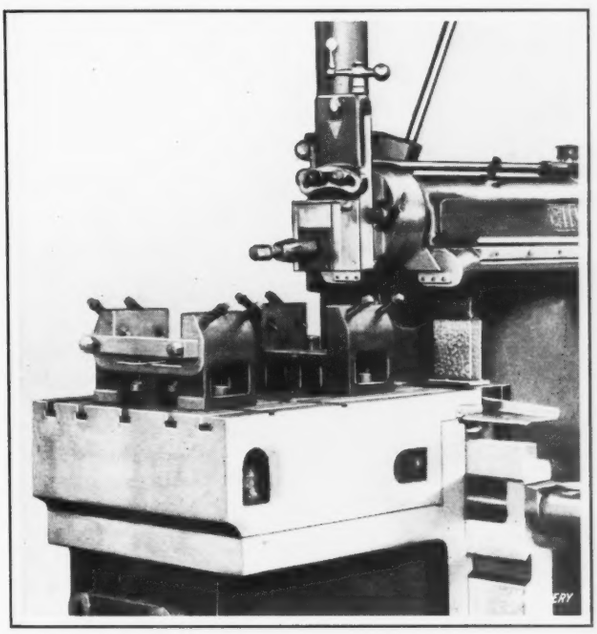


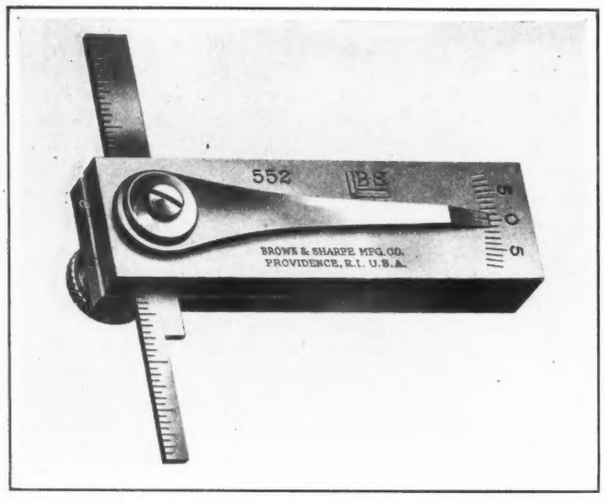
Fig. 3. Special Shoe and Wedge Chuck made in Two Parts

The vise furnished is of the double screw type, and of a compact design, with the working surface only 5 inches above the table. The jaws are 3 inches high by 15 inches long, and open 15 inches. As on the standard machine, a fully automatic oiling system provides adequate lubrication for all moving parts, including the rocker-arm mechanism, and for the ramways. Eight speeds are obtained through the internal transmission, which is enclosed in the column and runs at all times in a bath of oil. The desired speed is selected in the same manner as on an automobile. The various feeds are operated by cams and can be changed quickly.

BROWN & SHARPE DIEMAKERS' SQUARE

The diemakers' square shown in the illustration may be used for a variety of purposes in connection with diemaking and toolmaking. For example, this square can be employed for measuring the clearances of drop-forging dies, drawing and forming dies, and die-castings. It can also be used in toolmaking, either as a square or a depth gage, or for determining clearances. Various other applications will be apparent to those who have use for a tool of this kind.

A protractor is not required for setting this square, as the blade can be adjusted simply by moving the pointer to the required angular graduation. These graduations extend 8 degrees each side of the zero position, and the blade, which moves with the pointer, is clamped by tightening a



Brown & Sharpe Diemakers' Square

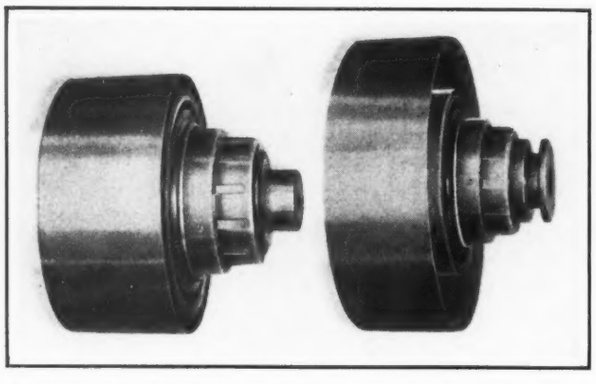
knurled nut. The blade is graduated in thirty-seconds of an inch on one side, and sixty-fourths of an inch on the other. The narrow end of the blade, for use in small holes, is 7/64 inch wide, and the other end is 7/32 inch wide. The body of the square is hardened and ground. This diemakers' square is an addition to the line of small tools made by the Brown & Sharpe Mfg. Co., Providence, R. I.

EDGEMONT TYPE E DISK CLUTCH

The Edgemont Machine Co., 2700 National Ave., Dayton, Ohio, is now manufacturing a type E disk clutch in connection with a complete line of pulleys, extended sleeves, cut-off couplings, and sprocket and gear blanks. This clutch is of the dry-plate type that has been used successfully in the automotive field. It is fitted with Fafnir transmission ball bearings and oiler bushings (cast iron or bronze) or plain bronze bushings. These clutches may be made to operate either singly or in pairs, and with cams for operating through the shaft, if desired. The illustration shows at the left a clutch pulley with cam for operating through the shaft, and at the right a clutch pulley with slotted cam.

The single adjustment of this clutch is made by loosening a screw in the yoke and turning an adjuster until the next slot is under the screw, the latter then being tightened. This draws up all studs equally and gives full liner contact and even distribution of the load on the various clutch parts. The woven asbestos metallic liners used have proved durable under adverse conditions, and are easily replaced, if necessary, at small cost. The roller construction of the levers makes this clutch easy to operate, little effort being required to throw it into engagement. The levers are so designed as to release instantly at all speeds.

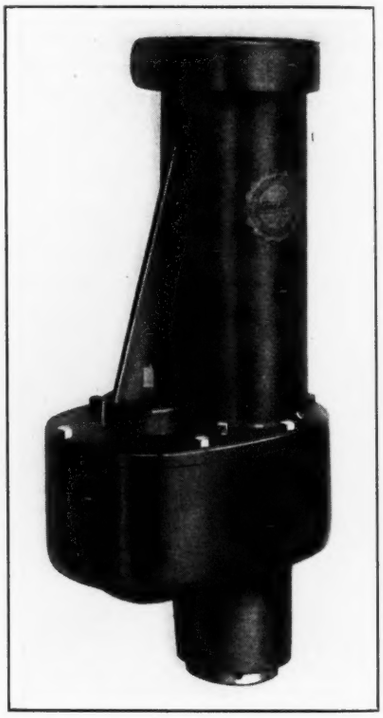
All working parts are fully enclosed, and the exterior is machined, which is conducive to neatness and safety. The clutch is light in weight, thus eliminating much of the flywheel effect in stopping. All parts are amply strong to withstand any loads within the capacity. This clutch is adaptable for various classes of machine drives, including machine tools.



Edgemont Clutch Pulleys with Cam operated through Shaft (Left) and Slotted Cam (Right)

HOEFER HEAVY-DUTY DRILL SPEEDER

The Hoefer Mfg. Co., Freeport, Ill., is now manufacturing the drill speeder shown in the accompanying illustration, which permits the use of large radial drilling machines, with their long range, and at the same time provides proper speeds for small drills; consequently, there is a definite saving in wear and tear on the large and expensive radial machine, and at the same time an increase in production. The speeder consists of a housing of suitable dimensions, with a nose and driver to fit the particular machine on which it is to be used, whether a No. 4, 5, or 6 Morse taper. This assures sufficient range beyond the requirements of this speeder, which has a 1 1/4-inch drill capacity.



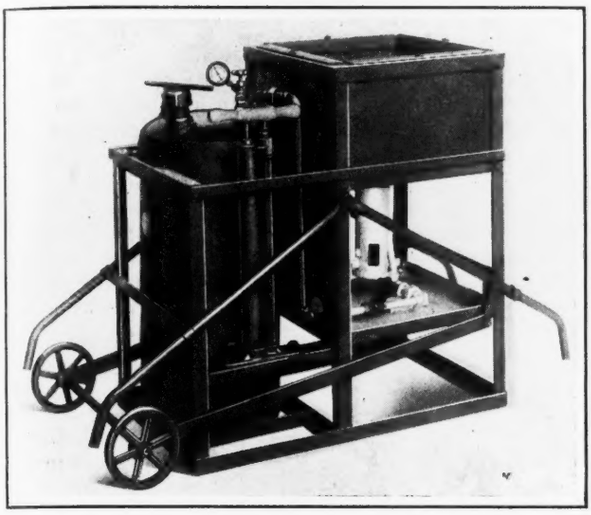
Hoefer Heavy-duty Drill Speeder

Gears of 2 inches width, with stub teeth of 6-8 pitch made integral with the spindles, assure ample strength. Gears and spindles are hardened, and the latter are accurately ground. Hyatt roller bearings are used on all spindle bearings, and end thrust is taken by Timken roller bearings. These bearings reduce friction to a minimum and insure continuous service. In spite of its rigidity and capacity, this speeder is very compact, measuring less than 12 inches through its largest cross-section. It can be attached or removed in a few minutes, with little effort.

CHAUSSE BABBITT- AND LEAD-MELTING FURNACE

Lead, babbitt, cyanide, etc., can be melted in a portable furnace recently produced by the Chausse Oil Burner Co., West Beardsley Ave., Elkhart, Ind. As illustrated, the furnace includes a Chausse oil-burning torch equipment with a retort, and is mounted on a frame provided with wheels. By lifting the handles at the rear, the wheels are lowered so that the furnace can be moved from place to place without tilting. When the handles are lowered, the wheels again rise to the position shown.

The heating chamber is 14 by 14 by 16 inches high, and is lined with firebrick with the flame entrance at the bottom. The tank holds twelve gallons of kerosene, which is sufficient for operating twelve hours at the maximum temperature. The burners deliver sufficient heat to melt 200 pounds of lead in from twenty to thirty minutes from a cold start, the maximum temperature generated by the burners being 1800 degrees. Any reduction in the amount of heat generated, of course, decreases the fuel consumption. An air



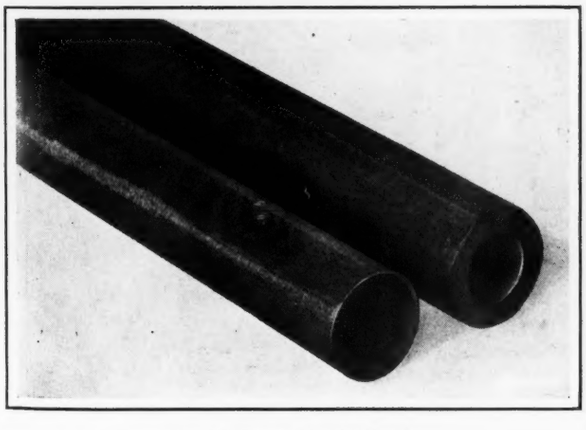
Chausse Portable Furnace designed for melting Lead, Babbitt, etc.

pressure between 10 and 20 pounds is maintained on the tank by means of a hand-pump. This furnace is 20 inches wide, 36 inches long, 33 inches high, and weighs about 160 pounds when empty.

CRILLY MERCURY BEARING METAL

Perhaps the ideal bearing metal is one that will continue to function normally the maximum length of time under any adverse condition, such for example, as would result from the complete failure of the oil film. The Crilly mercury bearing metal is said to possess desirable characteristics of this kind, as repeated tests have demonstrated that seizure between the shaft and the bearing will not occur even though the bearing is used for a long period without any lubrication whatever. Mercury metal is an alloy in which a soft plaster matrix of metal is held by a web of tougher metal, which, in running, tends to adjust itself to the minute irregularities of the shaft.

As an interesting test of the anti-friction qualities of this metal, a plain bushing with a 3/4-inch hole in it was placed on an unmachined cold-rolled shaft, the bushing being split and held in a 10-inch lever with an adjustable tension bolt to tighten the bushing on the shaft. The bushing was squeezed down on the shaft so that it was much tighter than it would ever be in actual practice. By revolving the shaft at 800 revolutions per minute and holding the bushing and lever against turning, it was found after hours of running, that the bushing did not score in the slightest degree nor had it tended to grip the shaft or mark it. In fact, after reaching a fairly high temperature the bushing tended to exude a slight lubrication which prevented further heating. The wear seemed negligible. It is claimed that one of the reasons for this remarkable performance is the fact that mercury metal has the property of expanding at the same rate as the shaft.



Crilly Mercury Bearing Metal

Crilly mercury bearing metal is distributed by the Metal Sales Co., 511 Bergen Ave., Jersey City, N. J., in solid and cored bar form (see illustration). The solid bars range from 3/4 inch to 6 inches in diameter, and the cored bars from 1 inch to 6 inches with various sized cores. The standard length is 12 inches, but longer bars can be supplied to order. Special shapes and casting are also made to order. The tensile strength of mercury metal is approximately 23,000 pounds per square inch, and the compression strength, 92,000 pounds per square inch. This metal is applicable wherever plain bearings are used.

OXWELD PORTABLE ACETYLENE GENERATOR

A small generator for producing acetylene at low pressure for welding and cutting has been developed by the Oxweld Acetylene Co., 30 E. 42nd St., New York City. This supplements a line of larger generators, a great many of which are used to supply pipe lines in shops where much cutting and welding is done. The new generator, which takes 35 pounds of carbide at one charge, can be transported readily from place to place, thus providing a portable supply of generated acetylene gas. Empty the generator weighs only 210 pounds.

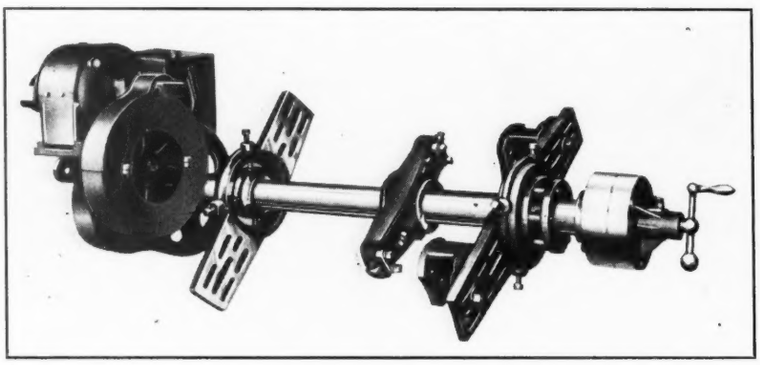
Oxweld Portable Acetylene Generator

An entirely new principle of feed control is used, which might be called a "heavier-than-water" float. A vertical partition, extending nearly to the bottom into a water seal, divides the generator shell. One side is gas-tight and contains the carbide hopper at the top. The upper part of the other side contains gas regulating and protective devices, and an automatic carbide feed control. Generation of the first acetylene causes water to rise on this side of the partition high enough to all but submerge a pan full of water, hung to a control lever. This pan normally acts as a weight acting counter to a spring, but as the water rises about it, its apparent weight is diminished and the carbide hopper valve is closed by the action of the spring. As acetylene is drawn off, water rises in the gas compartment and correspondingly lowers under the float, thus reducing some of the buoyancy under the water pan, which, gathering weight with the receding water, depresses the spring and allows a small amount of carbide to drop into the generator and restore equilibrium.

Because of its low center of gravity, the generator rights itself when tilting at an angle of 30 degrees, and works perfectly at an inclination of upward of 10 degrees. No adverse effects result if a generator, while in operation, is knocked over. Nearly all fittings are enclosed in the cylindrical shell.

ROOKSBY MOTOR-DRIVEN CYLINDER BORING-BAR

As many of the modern locomotive repair shops and roundhouses are equipped with electric motor-driven machines, E. J. Rooksby & Co., 1072 Hamilton St., Philadelphia, Pa., have developed and placed on the market a motor-driven portable cylinder and valve chamber boring-bar. An important feature of the design of this machine is the manner of driving the bar. The motor is mounted on a base that forms an integral part of the gear drive frame, and the speed reduction is obtained by gearing. The gear-box, having shifting gears, is provided with four or more changes, giving the operator a selection of cutting speeds suitable for all the cylinder diameters within the range of the bar. The gears have a positive-locking shifting device, are enclosed in a gear-case, and run in grease.



Rooksby Motor-driven Cylinder Boring-bar

These machines are furnished with either direct- or alternating-current constant-speed motors. Should a variable-speed direct-current motor be desirable, the speed gear-box is not required. The motor may be controlled by an ordinary switch or by an automatic remote-control magnetically operated switch, with a "start" and "stop" push-button station. The latter is a type particularly desirable in portable tools, as the push-button station can be mounted on the gear drive and the switch box put in any convenient place.

The main gear drive is provided with gear guards cast integral with the frame. The bars are made of the best grade open-hearth machine steel, accurately finished. When it is necessary to use more than one tool at a time, two tools, located diametrically opposite each other, produce the best results, and the double-arm cutter-head is designed to hold them in this position. The cutter-heads are fed along the bar by a totally enclosed feed-box, which is automatic and continuous in operation. The extra heavy tool-holder is designed to hold high-speed steel or stellite cutters, doing away with expensive forged tools.

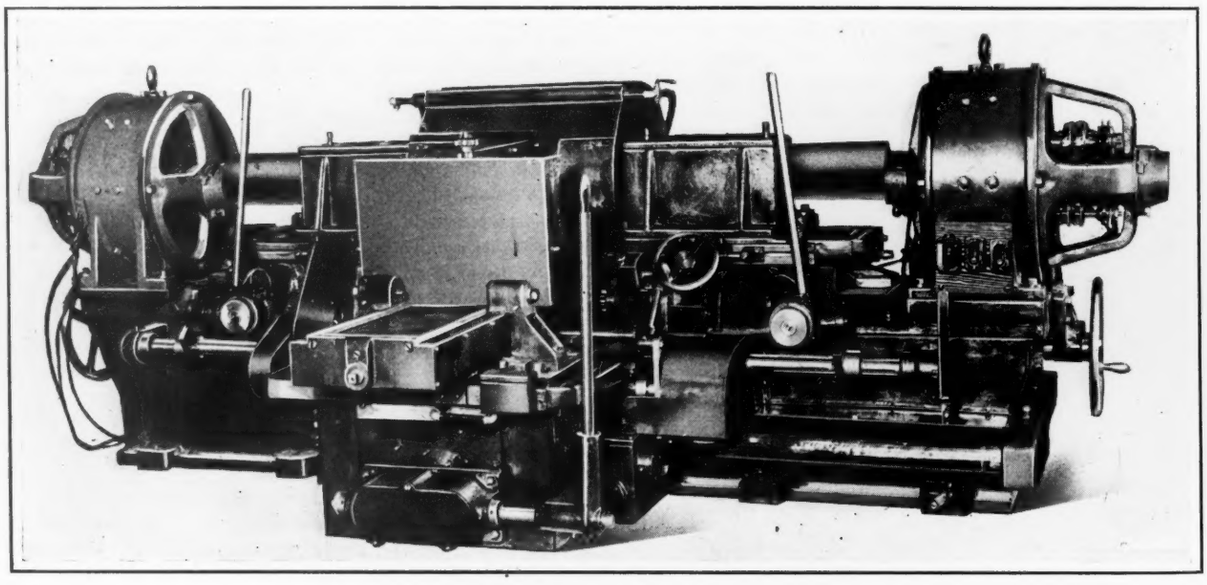
The machines are made in different sizes, the bars being 3 to 6 inches in diameter and designed to bore valve chamber bushings or cylinders from 7 to 48 inches in diameter.

BADGER DISK AND CYLINDER-WHEEL GRINDER

The Badger Tool Co., Beloit, Wis., has added to its line of disk and cylinder-wheel grinders, a new machine known as the No. 224. It is said to be the largest machine of this type ever built as a regular part of a line. The grinding principles employed are similar to those used in the smaller double-spindle grinders, but because of the increased dimensions throughout, the No. 224 machine is adapted for finishing larger areas than has been practical heretofore.

The accompanying illustration shows a front view of this machine. Either 24-inch diameter cylinder wheel chucks or 30-inch diameter disk wheels may be used. The main spindles are 3 3/8 inches in diameter, and each is connected to a standard 20-horsepower motor through a sliding coupling. There is a longitudinal travel of 2 inches in each sliding coupling, which is more than ample for any one set-up, but when large changes of opening between wheels are required, the sub-slides on which the motors are mounted are moved to the desired position and locked on the ways of the bed casting. The maximum opening between cylinder wheel chucks is 24 inches, and between disk wheels, 30 inches.

The sliding work-table is operated by power through reduction gears by a separate three-horsepower motor located at the right-hand end of the machine. The work to be ground is placed in a fixture attached to the inner end of the work-table, which reciprocates slowly in between the grinding wheels when the control lever is in the forward position. When the control lever is thrown way back, the work-table comes all the way out and stops, in which position the holding fixture is loaded. There is also a neutral position for the control lever. The grinding heads are opened and closed by power in proper relation to the cross travel of the table. Suitable micrometer stop-screws are provided to act independently on each grinding head. There is also a ratchet feed to allow the heads to come together one or more thousandths for each cycle of the work-table. A wheel dressing device is attached to the rear of the ma-

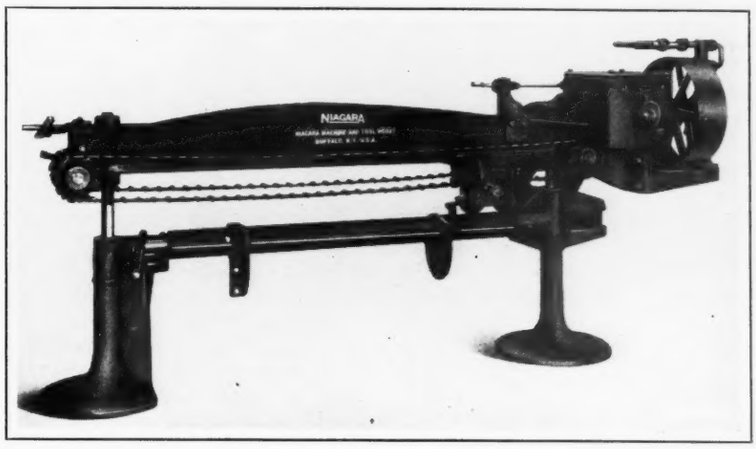


Badger Grinder which may be equipped either with Disk or Ring Wheels

chine, and the wheels can be dressed even while the work is being ground. This grinder is built for either belt or motor drive, and arranged for either wet or dry grinding. It is 15 feet long by 7 feet wide, and weighs 14,000 pounds.

NIAGARA POWER GIANT GROOVERS

The line of power giant groovers made by the Niagara Machine & Tool Works, Buffalo, N. Y., has been redesigned and several new sizes have been added. These machines are intended for grooving longitudinal seams of long cylinders. They are made in 4-, 6-, 8-, and 10-foot lengths, and each length is made in three sizes having a capacity of 20, 18, and 16 gage, respectively. The horn which supports the work can be swung sideways for removing the cylinder. On long machines a counterbalance for the horn is provided.



Niagara Power Giant Groover for grooving Longitudinal Seams of Long Cylinders

A moving carriage carries the grooving rolls, which are pivoted in rocking cradles. One roll is in action on the out stroke, and the others on the return stroke, the change taking place automatically. The carriage is driven by a sprocket chain. It reverses and stops automatically. It can be operated from either end and started or stopped at will. One of the outstanding features of the new design is the reversing mechanism, which consists of a double friction clutch completely encased and running in grease. This construction does away with the mechanism necessary for automatically shifting cross belts.

All groovers are built with complete adjustments, including adjustable gages or stops, adjustments for various thicknesses of material, a revolvable horn for either inside or outside seams of various widths, and an assortment of grooving and flattening rolls. These machines can be arranged for either belt or motor drive.

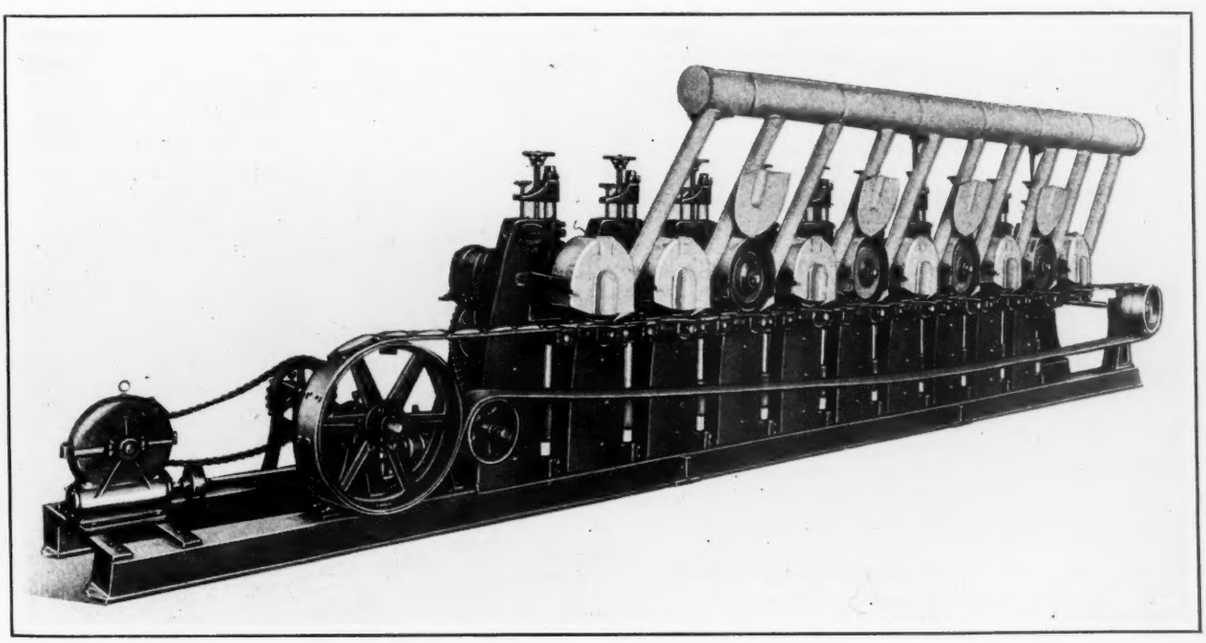
EXCELSIOR AUTOMATIC GRINDING AND POLISHING MACHINE

A machine for grinding and polishing various parts, such as castings, forgings, stampings, sheet-metal strips, angle-iron, or other straight and flat-surfaced parts of uniform thickness, is a recent product of the Excelsior Tool & Machine Co., 30th to 32nd St., Ridge to Jefferson Ave., East St. Louis, Ill. The work is placed on a conveyor belt, and is traversed under the grinding and polishing wheels at about 25 feet per minute or more, according to requirements.

The spindles may be equipped with solid abrasive wheels throughout, or part of them may have canvas polishing wheels, depending upon the nature of the work. The ball-bearing wheel-spindles are directly connected to 7 1/2-horsepower motors mounted on vertical self-contained sliding frames which are balanced and adjustable for any desired wheel pressure. The height from the grinding wheel to the conveyor belt can be varied by means of an adjustment that is provided at the top of each vertical housing. The wheels are always free to follow any slight irregularity if this is required, and they are also free to rise clear of any obstruction that might arise due to accidental insertion of material too thick to pass freely under the wheels.

The solid abrasive wheel capacity is for diameters up to 14 inches, whereas for polishing wheels the maximum diameter is 16 inches. The speed is 1800 revolutions per minute. Each wheel can be dressed without removing it or stopping the machine, a rotating dresser sliding on a wedge set parallel to the wheel being used. This wedge is adjusted inward to force the dressing tool against the wheel.

A separate three-horsepower motor is required to operate the feed belt, and a vibrating shaft for vibrating the feed

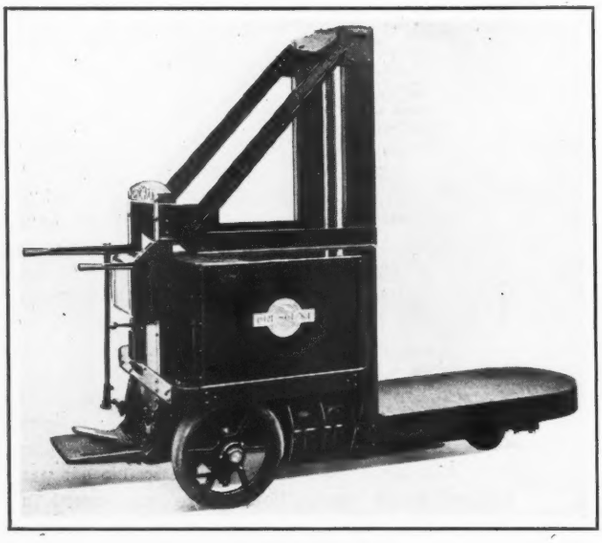


Excelsior Ten-wheel Automatic Grinding and Polishing Machine

tables and belt about 1/4 inch sideways to prevent straight-line scratches and also the wearing of grooves in the wheels. The latter are set about 5 degrees out of line with the feed belt to further improve the cutting quality and finish. Each table has a roller inserted directly under the wheel and flush with the top face of the table to reduce conveyor belt friction. These machines are made in three-wheel, six-wheel and ten-wheel sizes, the latter size being shown in the illustration. Dust hoods and an exhaust manifold are furnished with each machine, as shown, so that they can be readily connected to a fan or exhaust system.

CRESCENT TIER-LIFT TRUCK

The Crescent Truck Co., Lebanon, Pa., now manufactures a tier-lift truck (type GEH) which has the following features and dimensions. The elevating unit is operated through a worm and worm-wheel and a single screw, the latter being visible in the accompanying illustration. This elevating unit is equipped with ball bearings and runs in oil. The truck has a lifting capacity of 4000 pounds, lifting a load to a height of 6 feet. The platform of the truck is 26 inches wide and 54 inches long. The over-all height of



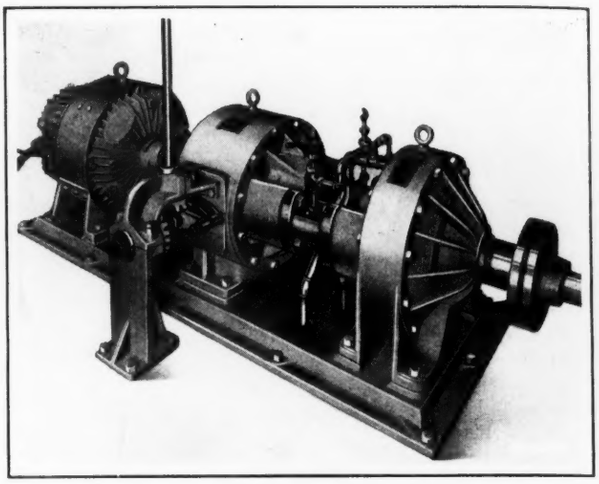
Crescent Tier-lift Truck

the truck is 87 inches, the over-all width 41 inches, and the over-all length 112 inches. The wheel-base is 59 inches, and the turning radius, 95 inches. All working parts are mounted beneath the truck platform and are accessible. The driving unit of the truck is interchangeable with all other Crescent units.

AMERICAN ENGINEERING CO.'S SPEED-REDUCTION UNIT

A gearless speed-reduction unit in which hydraulic pressure is utilized is being placed on the market by the American Engineering Co., Philadelphia, Pa. High efficiency, through the elimination of friction between the gear teeth, is claimed for this device. Its outstanding feature, however, is that the ratio of reduction can be instantly varied in any desired degree without stopping the direct-connected electric motor or changing its speed. This makes it possible to change the ratio to overcome varying resistance.

Essentially, the unit consists of a Hele-Shaw hydraulic pump and a Hele-Shaw hydraulic motor. The pump, in general appearance, resembles an electric motor of the enclosed type. Inside the casing a cylinder body with radial cylinders rotates at constant speed around a central cylindrical valve, through which the fluid passes to and from the pump. Plungers with slippers fastened to their ends are forced in and out as the slippers travel around in a



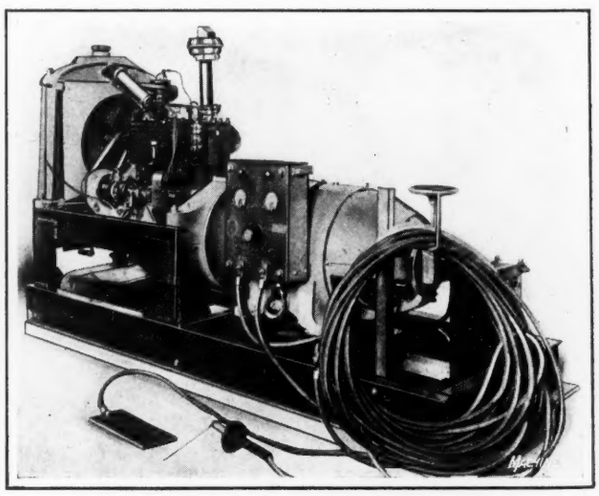
Speed-reduction Unit of the Hydraulic Type, made by the American Engineering Co.

groove in an outer floating ring. By shifting the position of this ring, the stroke of the plungers, and consequently the discharge from the pump, is regulated from zero to a maximum, giving an infinite range of speeds to any mechanism driven by the pump. The regulation of the plunger stroke is accomplished while the machine is running without changing the speed of rotation, which remains constant.

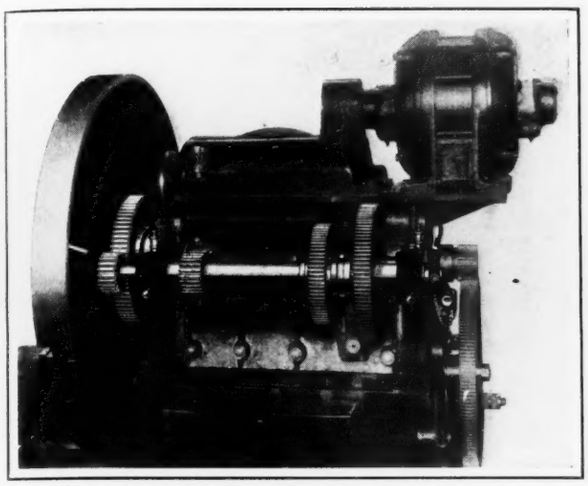
The Hele-Shaw pump has been adapted to driving various machine tools and other mechanisms in which rams or other reciprocating parts are used, such as planers, presses, broaching machines, stokers, testing machines and similar devices. The combination of the pump and motor in one unit adapts it for use in rotary drives as a speed reducer. The particular unit shown in the illustration drives the anchor windlass on a steam yacht, and it gives reductions up to 850 to 1.

GENERAL ELECTRIC WELDING SET

An engine-driven welding set recently added to the line of welding equipment made by the General Electric Co., Schenectady, N. Y., is shown in the accompanying illustration. This outfit consists of a standard WD-12 welding generator, driven by a Buda engine, and is mounted on wooden skids to facilitate moving it from place to place. The engine is a four-cylinder, four-cycle L-head type, with 3 3/4-inch bores and a 5 1/8-inch stroke. The S. A. E. rating is 22.5 horsepower, and at 1400 revolutions per minute the actual brake horsepower is 33. The unit is particularly adapted for repair work in locomotive roundhouses; for constructing pipe lines and tanks; for making repairs in oil fields or on ships; or for other jobs where electric power is not available.



General Electric Engine-driven Welding Equipment



Rahn-Larmon Geared Faceplate Drive in Mesh

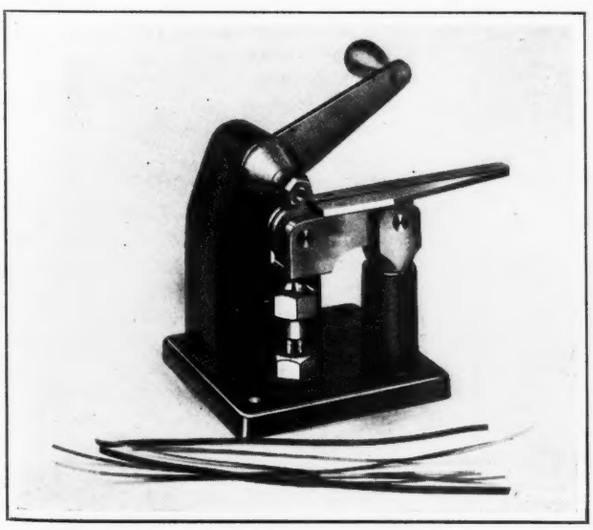
RAHN-LARMON GEARED FACEPLATE DRIVE

A geared faceplate drive is a new feature on the 22/40, 24/48 and 28/48 series G extension-bed gap lathes made by the Rahn-Larmon Co., Cincinnati, Ohio. With this drive, power is transmitted directly from the back-gears to a gear on the large faceplate. The back-gear shaft is extended (as shown in the accompanying illustration) and a pinion on it meshes with a large steel gear fitted to the faceplate hub. This arrangement provides a powerful drive and a steady cut for turning the largest diameters. It is claimed that this drive makes it possible to take cuts fully 50 per cent heavier than could be taken otherwise; moreover, chatter marks on finished work are prevented.

The driving pinion is shifted into or out of mesh with the faceplate gear by the lever seen at the right in the illustration. When out of mesh, this pinion is close to the back-gear shaft bearing, so that it does not project and thus interfere with the use either of the small driver plate, the regular 24-inch faceplate, or the chuck. All gears are made of steel and are properly guarded.

NOBLE & WESTBROOK STRIP STOCK MARKING MACHINE

The marking of gold solder that requires a continuous mark to designate quality led to the development, by the Noble & Westbrook Mfg. Co., 19 Asylum St., Hartford, Conn., of a small bench type of marking machine for work of this kind (see illustration). With this machine, the material is fed between two rolls, the top roll being lettered and the bottom one being grooved to carry the stock central. The crank-handle is placed at the back of the machine, and through gears in the casting, speeds up the action of the rolls in the ratio of 2 to 1; by this means a rapid production is secured.

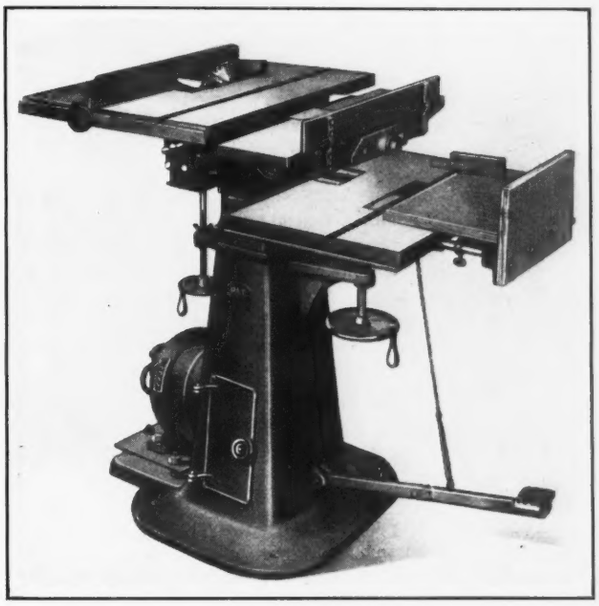


Noble & Westbrook Machine for marking Strip Stock

Provision is made for marking different thicknesses of stock, and while the whole machine weighs only 10 pounds, it is rigid and substantial throughout, and can be adapted to mark a continuous line of lettering with letters up to 5/32 inch high on stock 3/4 inch wide or less.

COMBINATION WOODWORKER

The combination woodworker now being manufactured by the Combination Woodworking Machine Co., Inc., 152 N. Desplaines St., Chicago, Ill., is said to have fewer bearings and moving parts, and to be adaptable to a larger variety of operations than other machines in this class. The spindle is the only rotating member, and there are only three shaft bearings in the entire machine, two of which are ball bearings. The makers claim that this machine will do all the work of any saw table, jointer, thickness planer, boring table, and speed spindle, within certain limits of size. A folder relating to this machine illustrates twenty entirely different operations, and there are many other special operations possible, according to the needs of the user. The thickness planer on this machine planes any number of pieces to the same thickness, anywhere between 4 inches and 3/16 inch.



Combination Woodworker for doing the Work of a Saw Table, Jointer Thickness Planer, Boring Table and Speed Spindle

This machine (see illustration) has a heavy base and a low center of gravity, which makes for stability. The high-speed saw and cutters are all enclosed and guarded to prevent accidents, and work is done in the usual ways which the ordinary machine-hand understands. Changes in "set-up" are quickly and easily made; in fact, different parts of the machine may be ready at the same time to perform four operations. One operator may be using the saw table while another is using the jointer, thickness planer, boring table, or the end of the speed spindle for any of its various operations. This machine has a minimum of bearing friction, and a one-horsepower motor is sufficient for most uses, although a larger motor can be easily substituted, when desired.

LIBERTY OPEN-SIDE PLANER

There are many classes of work for which the greater convenience of the open-side planer is conceded; but some users of planers have been reluctant to buy machines of this type, fearing that it is impossible to obtain the necessary degree of rigidity with the cross-rail supported only at one end. In the new open-side planer which the Liberty Machine Tool Co., Hamilton, Ohio, is now announcing to the trade, a high degree of rigidity for the cross-rail support has received especial attention, with a view to overcoming the possible prejudice of those who would like to use open-side machines for jobs that cannot conveniently be set up on a planer with two housings. That this effort has been successful is well attested by the fact that under test on cast iron, with a cut 1 1/2 inches deep and a feed of 1/4 inch, the maximum deflection at the outer end of the rail was found to be only 0.0035 inch.

This degree of rigidity is attained through the provision of an unusually massive knee on which the cross-rail is mounted. The knee has liberally proportioned bearings on the column, and is furnished with an arrangement of gibs for positively locking it in any desired position. A general view of the planer is shown in Fig. 1, and Fig. 2 gives a good idea of the proportions of the knee. Locking of the knee in any desired position is accomplished by a hand-crank on shaft *A* which transmits motion through two pairs of bevel gears to a vertical screw connected with a taper gib. Turning of the handwheel pulls this gib up, and affords liberal locking power through the combined multiplying action of the screw and the wedge.

In January, 1925, MACHINERY, a description was published of the new Liberty planer which was just being announced to the trade at that time. This machine was of the double-housing type. The present open-side planer includes all of the important features incorporated in the double-housing machine. For example, one motor is employed for driving the table of the open-side planer, while independent motors are furnished for the rail- and the side-head, as in the double-housing planer. This arrangement eliminates all overhead works and makes the cross-rail and the side-head fully independent units, capable of employing any feed or rapid traverse movement, regardless of any other consideration aside from the most efficient use of the head which it is desired to apply to some particular purpose.

Elevating or lowering the cross-rail and also the power rapid traverse of the rail-head vertically and horizontally are accomplished by manipulating a single lever *B*. With this arrangement it is impossible to engage two different movements simultaneously, thus furnishing a "fool-proof" control for the rail. Feeding of the head vertically and horizontally is controlled by lever *C*, and the desired rate of feed is obtained by turning the small handwheel *D*, the latter being connected with the dial *E* which shows the rate of feed for which the setting has been made. The electric motor which furnishes these movements is of 1 1/2 horsepower and receives current through a protected trolley that contacts with conducting strips fastened to the housing. Either alternating or direct current can be used, and, if necessary, it may be taken from a lamp socket.

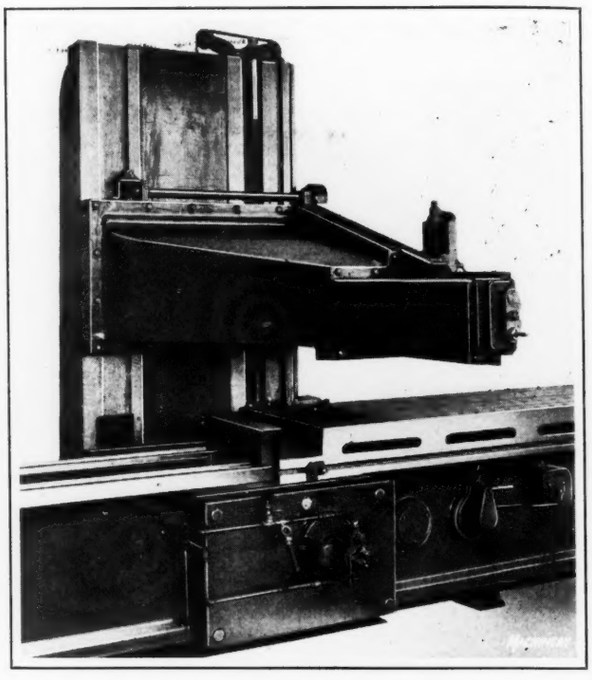


Fig. 2. View of Liberty Open-side Planer showing Proportions of Column and Knee

The screws that move the head on the cross-rail and the side-head on the housing are held stationary and in tension, movement of the heads being accomplished by the rotation of a nut on the screw. Lever *F* provides for controlling the horizontal feed of the head on the rail or the vertical feed of the tool-slide. The vertical movement of the tool-slide is also effected by revolving a nut around a stationary screw held in tension. Similarly, the screw for elevating and lowering the cross-rail is held stationary and in tension. Vertical shaft *G* is simply employed for transmitting power to the feed mechanism of both the rail-head and side-head. The transmission gears are so arranged that throwing lever *H* into two different positions causes the feed to occur either at the end of one cut or just before starting a new cut.

All mechanism at the end of the cross-rail, and that controlling the feed and power rapid traverse of the side-head, as well as the feed reversing mechanism at the bottom of the housing, runs in oil. Gages indicate the level of the oil at these points. It will be noted that the housing extends right down to the floor, and it is attached to the bed by means of bolts, fitted into reamed holes. Additional heavy dowel-pins eliminate any movement between the housing and the bed. The latter is of the double-wall type, ribbed both lengthwise and crosswise and webbed at the top. Provision is made for forced-feed lubrication, the pump and control valve

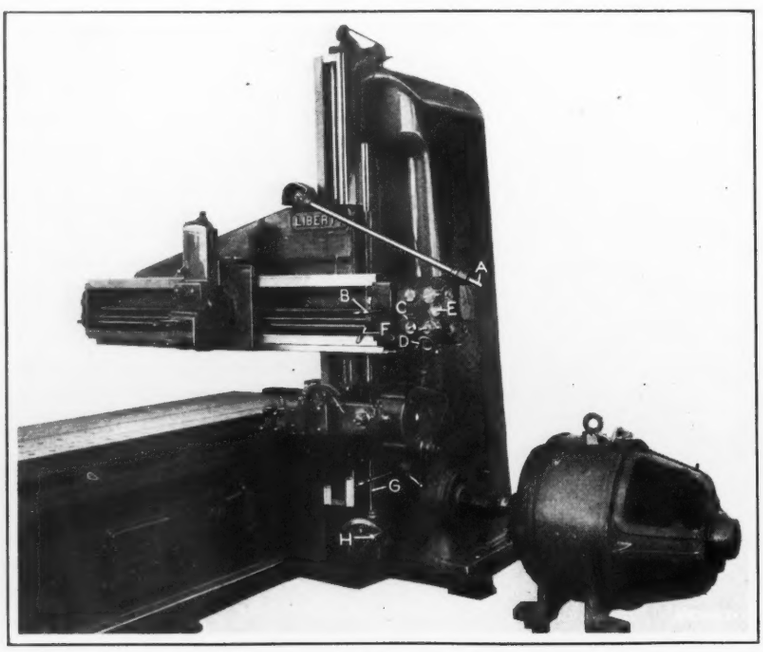


Fig. 1. Liberty Open-side Planer

of this system being located on the outside of the housing. In addition, there is a sight-feed attachment which enables the operator to see whether the system is functioning properly. All oil entering the bearings is filtered through a sequence of filtering stations in the bed and then passes through a 1/2-inch felt wick.

The planer bed is twice the length of the table so that the latter never extends beyond the ends. A balanced drive is obtained through the use of herringbone gears, which eliminate friction and side thrust. These gears are made of heat-treated steel and they are contained in a box cast into the bed to provide for running the gears in a bath of oil.

FLYNN MICROMETER BORING HEAD

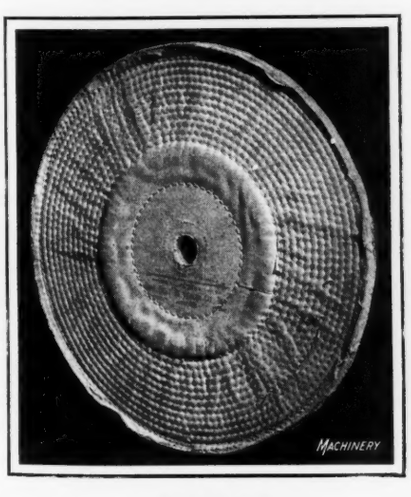
A micrometer boring head designed for heavy work on horizontal boring and milling machines and for similar service has been brought out by J. M. Waterston, 425 Woodward Ave., Detroit, Mich. This compact boring head is 7 1/2 inches in diameter and 3 1/2 inches long, so that it has very little overhang, which makes it rigid and gives maximum travel on all machines. The jaws and jaw screws are made of nickel steel, heat-treated and ground. The jaws open and close from 0 to 1 1/2 inches, which permits the use of any boring-bar up to 1 1/2 inches.

This head runs concentric and has an offset of 1 inch, which in a complete revolution gives a boring range of 2 inches from the original setting without changing the boring-bar or fly cutter. When the slide is locked in the central position, the jaws open and close so that all bars or drills run true. The dial is graduated in thousandths of an inch for accurate adjustment in boring. The weight is 28 pounds.

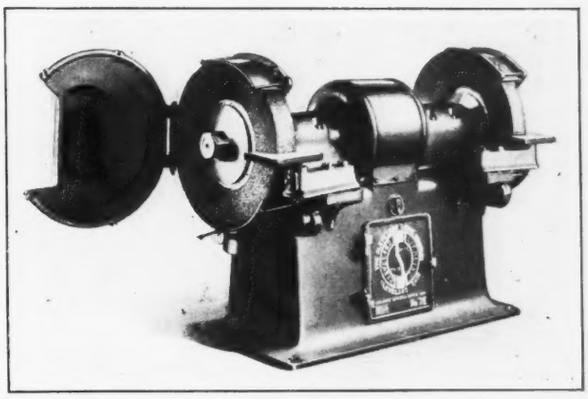
"BIASPLEX" BUFF

A new type of sewed buff known as the "Biasplex," is a recent product of the Bias Buff & Wheel Co., Inc., 342 Madison Ave., New York City. Like the "Bias buff," the "Biasplex" incorporates the bias principle, with certain modifications and changes desirable in a full-sewed wheel. The result is a hard, extra-fast cutting wheel that can be used on any work where a pierced buff or a whole-layer sewed buff is now used. The standard "Biasplex" is made 30 ply, in either bleached or unbleached sheeting. For most work, the unbleached sheeting is recommended, as it cuts faster than an ordinary sewed buff made of bleached goods.

A comparison between the new "Biasplex," a pierced buff, and a whole-layer sewed buff shows that a "Biasplex" buff of five sections has a 2 1/4-inch face; a whole-layer sewed buff with five sections has a 1-inch face; a pierced buff with five sections has a 1 1/2-inch face (average). It is a difficult matter to make an exact comparison between the "Biasplex" and a sewed pierced buff, because some manufacturers make a thick pierced buff, and others, thin sections; therefore, the foregoing comparison, while accurate as far as it refers to a whole-layer sewed buff, is approximate as compared to a pierced buff. It is claimed that the "Bias-plex" buff is accurately balanced and uniform in weight.



"Biasplex" Buff



Cleveland Stone Co's Grinder for Heavy-duty Foundry Grinding

CLEVELAND STONE CO.'S GRINDER

A grinder for heavy-duty foundry grinding has been brought out by the Cleveland Stone Co., Cleveland, Ohio. This grinder is known as the No. 7E. It is driven by a special 10-horsepower Lincoln motor, having a speed of 900 revolutions per minute, and it can be supplied for operation either with 440 or 220 volts alternating current. Either an industrial push-button control or a compensator is furnished. The two wheels are 24 inches in diameter, and may have a thickness up to 4 inches. The main shaft is 3 1/4 inches in diameter, the wheel ends, 2 1/2 inches in diameter, and S K F ball bearings are used throughout. The driving shaft and motor housings are practically free from holes and projections that catch dirt, so that the grinder is easy to keep clean. This grinder can be entirely disassembled and assembled again in less than two hours, there being only eight bolts to loosen in order to remove the wheels, shaft, and bearings.

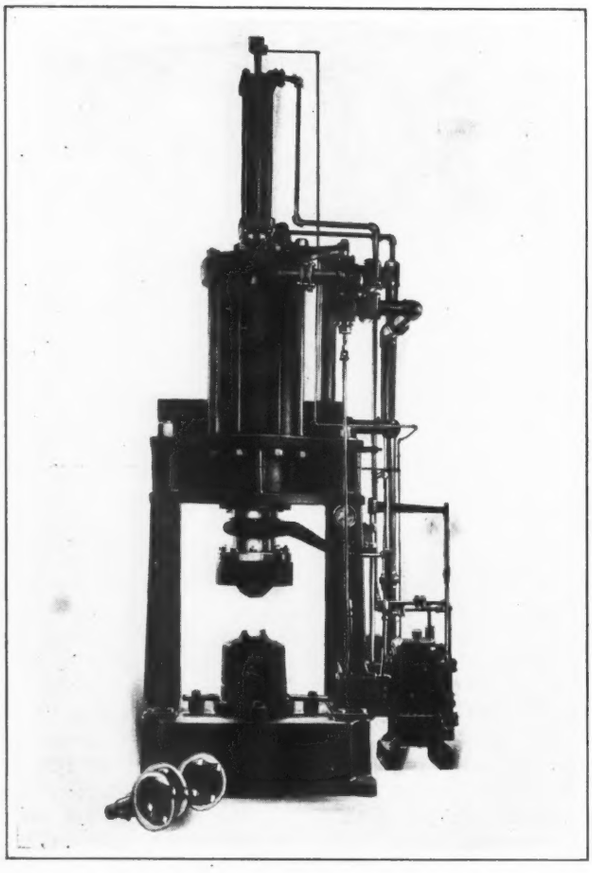
OILGEAR STRAIGHTENING PRESS

A press has been brought out by the Oilgear Co., 657 Park St., Milwaukee, Wis., to meet the demand for a better method of straightening malleable iron and steel castings. With the Oilgear principle of a smooth flow of oil to a hydraulic cylinder under perfect control, the castings are subjected to a quick squeeze, rather than a sudden blow, which results in giving the metal time to flow into the desired shape. Thus, the castings retain their proper shape, instead of springing back.

The new press, which is built in 50- and 100-ton sizes, is equipped with a high-speed cylinder for advancing and withdrawing the ram to and from the work rapidly, thereby reducing the time required for traversing the ram through the loading space. The squeeze is accomplished by a large cylinder. The flow of oil from the pump to the press is controlled by a single foot-pedal, which allows the operator the use of both hands at all times.

As the dies come into contact with the work, an automatic valve shifts the flow of oil from the high-speed traversing cylinder to the large squeezing cylinder, so that no time is wasted. When the casting has been straightened, the ram is returned quickly to its upper position by the small cylinder. All the operator has to do is to set the casting to be straightened in the lower die and depress the foot-pedal until the ram squeezes the work; he then releases the foot-pedal, allowing the ram to return to the starting position at high speed.

The control mechanism is equipped with adjustable stops, so that the ram may be stopped at any point in its stroke. The ram never travels more than is necessary to clear the work and to permit loading and unloading of dies. If desired, double dies may be used, so that one die is being loaded while the ram is operating on the other. In this way, the ram need only operate over a very short stroke, as loading and unloading take place at one side. An extra cylinder



Oilgear Press for straightening Malleable Iron and Steel Castings

and valve, placed convenient to the operator, can be used to shift one die out from under the ram and set the other die in place.

One of the 50-ton presses is installed in a plant for truing malleable brake bands. The dies are made in such a way that the bands are brought to a true circle and made to lie flat on one edge, in one operation. The machine has increased production 50 per cent, and eliminated four men. All rejections have been eliminated. In another plant, using a 100-ton press, rear carrier housings are straightened at the rate of 250 pieces per hour. The castings weigh 27 pounds each, and two operators run the press, using double dies.

* * *

THE OUTLOOK IN THE RAILROAD FIELD

One important factor in the year's business in the metal-working industries has been the smaller volume of railway equipment buying. The American Railway Association estimates that the total buying for the first five months of the year has amounted to about $750,000,000, as compared with $875,000,000 last year, and $1,060,000,000 in 1923. The reason for this is that the railroads are unusually well equipped as far as rolling stock is concerned. While, during recent weeks, freight loadings have been unusually high, nevertheless the surplus freight cars available have numbered approximately 300,000. All told, the railroads have installed 400,000 new freight cars since January 1, 1923, and during the present year about 100,000 cars have been installed or ordered. Railroad men expect the largest railroad traffic in the history of American railroads this year.

* * *

What is claimed to be the world's largest electric locomotive has recently been built by the Westinghouse Electric & Mfg. Co. for the Virginian Railway. This locomotive has a rating of 7125 horsepower and weighs between 500 and 600 tons. It is stated that thirty-five additional engines of this size will be ordered later.

SILENT CHAIN DRIVE FOR PLANER

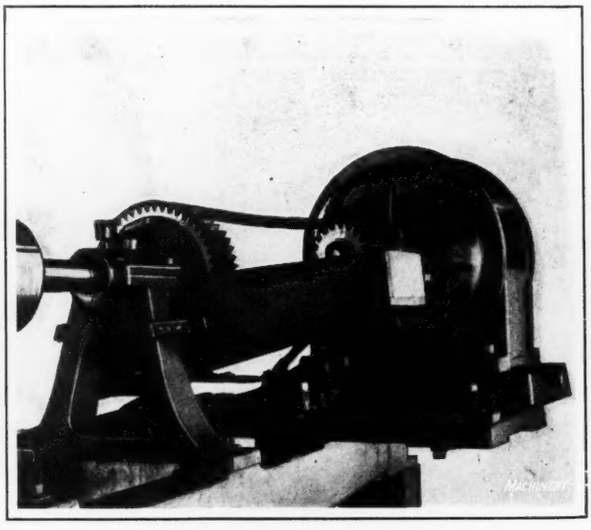
By DONALD A. HAMPSON

Noise from gearing affects the efficiency of the workman and is more nerve-racking when it is intermittent than when constant. For many years various non-metallic substances have been used as gear materials with the object of eliminating the metal-to-metal contact that is the chief cause of noise when metal gears are operated at high speed. In some cases, the use of a silent chain drive in place of gears has been a satisfactory means of eliminating objectionable noise. This was found to be the case in dealing with a noisy planer drive.

The drive in question consisted of spur gears having a ratio of 21 to 48, which connected a 20-horsepower motor with the overhead countershaft of a planer. The noise was deafening, and no relief was obtained with any of the several types of pinions designed for quiet operation. A careful checking up from time to time showed that the noisy operation was not caused by misalignment of the shafts. In a last attempt to lessen the noise, a silent chain drive was installed. This drive proved satisfactory, although it was not unconditionally guaranteed by the maker to accomplish the desired end.

The silent chain drive is shown in the accompanying illustration. A 19-tooth driving sprocket runs at a speed of 1100 revolutions per minute and drives a 45-tooth sprocket on the countershaft, the driven sprocket being of the compensating spring type. The purpose of the spring construction is to absorb the shock of reversal and relieve the chain of stresses. The period of greatest noise with the spur gear installation was at the point of reversal, but the combination of spring and silent chain apparently smoothed over this peak, so that only a continuous hum was audible when the planer was in operation.

While chains are not the customary means of driving planers, the results obtained in the case described indicate that they can be used satisfactorily for this purpose. It will be noted in the illustration that the motor is placed at the extreme end of the baseplate that is connected to the countershaft supports. This installation gave a center distance between sprockets of only 15 inches, which was considered rather short, but it gave good results and was preferable to locating the motor at a greater distance where it would have a greater overhang. The box that encloses the sprockets and chain is shown with the upper half removed. This box is intended to catch any grease that may drip from the drive and also to serve as a protection against injury to the workmen. The cost of a chain drive such as described may at first thought seem rather high, but tests have shown that the longer life of this type of drive will more than compensate for the greater cost.



Silent Chain Drive used for Planer

PERSONALS

A. P. EMMERT, formerly general superintendent of the Warner Gear Co., Muncie, Ind., has been placed in charge of the axle plant of the Hudson Motor Car Co., at Detroit, Mich.

G. H. WEBB has been appointed Philadelphia sales manager of the Central Steel Co., Massillon, Ohio, succeeding the late A. B. COOPER. Mr. Webb has been identified with the company for over eleven years.

ELLIOTT A. ALLEN has been appointed district sales manager for the Timken Roller Bearing Co., Canton, Ohio, in the New England territory. Mr. Allen will maintain an office at 1107 Commonwealth Ave., Boston, Mass.

P. A. E. ARMSTRONG, for eight years vice-president and general manager of sales for the Ludlum Steel Co., Watervliet, N. Y., has resigned and will be succeeded by HILAND G. BATCHELLER, for the last ten years vice-president of the company.

FRANCIS A. EMMONS, advertising manager of Foote Bros. Gear & Machine Co., 232-242 N. Curtis St., Chicago, Ill., was elected secretary of the Engineering Advertisers' Association of Chicago at the annual meeting held at the Congress Hotel on June 8.

HENRY F. RUSSELL, formerly of the Lumen Bearing Co., has been appointed sales manager of the Sumet Corporation and the Cored Bar Corporation, of Buffalo, N. Y. The latter company manufactures cored and solid bars cast from Sumet bronze bearing metal.

H. J. PORTER, who has been general sales manager of the Timken Roller Bearing Co., Canton, Ohio, is now vice-president in charge of sales. L. M. KLINEDINST, formerly assistant to Mr. Porter, has been appointed general sales manager of the industrial division.

H. L. BARNES was elected general manager of the American Forge & Machine Co., Canton, Ohio, at a meeting of the board of directors, June 1. Mr. Barnes was formerly with the Whitman & Barnes Mfg. Co., and has had many years of experience in the forging business.

ROBERT A. WILSON, who for the last ten years has been associated with the Baush Machine Tool Co. in various engineering capacities, and who has had charge of the Chicago office for the last two years, has been appointed chief engineer for the Hoefer Mfg. Co. of Freeport, Ill.

E. J. FULLAM, secretary and treasurer, and W. F. SLOMER, general sales and service manager of the Fellows Gear Shaper Co., Springfield, Vt., sailed June 9 on the *Aquitania* on a business trip to England, France, Germany, Belgium, Switzerland, and Italy. They expect to return about the second week in August.

L. A. WOODARD, formerly president of the Woodard Machine Co., Wooster, Ohio, is now president and general manager of the Tri-State Engineering Co., Zanesville, Ohio. R. A. SNYDER is superintendent, and C. A. REESE, purchasing agent. Mr. Snyder and Mr. Reese were also formerly connected with the Woodard Machine Co.

FRANK A. HUNTER was recently elected president and general manager of the Hunter Saw and Machine Co., of Pittsburg, Pa., succeeding his brother, the late Harry S. Hunter. JOSEPH KENNEDY remains vice-president; R. E. VAUGHN, formerly secretary, was elected treasurer; and FRANK A. HUNTER, JR., was elected a director.

GUISEPPE FACCIOLI, engineer of the Pittsfield plant of the General Electric Co., sailed on June 6 on the S. S. *Paris* for an extended European trip. Mr. Faccioli will attend the third international conference on high voltage systems in Paris, and will visit the principal cities of France, Germany, Austria, and Czecho-Slovakia.

HEMAN ELY, vice-president of the Timken Roller Bearing Co., Canton, Ohio, since 1920 and treasurer since 1916, has retired from active connection with the company. Mr. Ely has been associated with the company for sixteen years, first as secretary, later as treasurer, and for the last five years as vice-president and treasurer.

W. C. DAVIS, president of Foote Bros. Gear & Machine Co., 232-242 N. Curtis St., Chicago, Ill., started June 15 on a trip to the Pacific Coast. He intends to visit the company's branch offices at Denver, Salt Lake City, Los Angeles, San Francisco, Portland, and Seattle. On the return trip he will take the Canadian route, visiting several of the branches of Darling Bros., who are Canadian distributors for Foote products.

E. F. W. ALEXANDERSON, consulting engineer of the General Electric Co., and inventor of the Alexanderson high-frequency alternator, which made trans-oceanic radio communication possible, sailed June 13 on the *Majestic* to attend the official inauguration of Sweden's new high-powered radio station at Varberg. Two of the Alexanderson alternators have been installed in this station, which has already been in direct communication with the Radio Corporation station on Long Island.

DAVID AYR has been appointed assistant factory manager of the Pratt & Whitney Co., Hartford, Conn. Mr. Ayr was until recently connected with the American Radiator Co., of Buffalo, N. Y., as assistant general manager of the equipment plant. Previously he was general manager of the Russell Gear & Machine Co. of Toronto, and he has also been connected with the Gurney Ball Bearing Co., Jamestown, N. Y., the Pierce-Arrow Motor Car Co., Buffalo, N. Y., and the Brown & Sharpe Mfg. Co., Providence, R. I.

W. B. MCSKIMMON, one of the founders of the Union Twist Drill Co., Athol, Mass., and an executive of the company since its inception twenty years ago, has been elected president of the company to succeed the late J. A. McGregor. The Union Twist Drill Co. also owns the S. W. Card Mfg. Co., of Mansfield, Ohio, and the Butterfield Tap & Die Co., of Derby Line, Vt., and Rock Island, Canada. Previous to being elected president of the Union Twist Drill Co., Mr. McSkimmon was treasurer of the S. W. Card Mfg. Co., and secretary, vice-president and general manager of the Union Twist Drill Co. and its subsidiaries.

FIELDER I. HISS, formerly with the Crocker-Wheeler Co., is now chief engineer and assistant to the sales manager of the Triumph Electric Co., Cincinnati, Ohio. Mr. Hiss was born in Baltimore, Md., but was educated abroad, graduating as an electrical engineer from Finsbury College, England, in 1902. Later he was designing engineer for Johnson & Phillips, of London. In 1906 he went with the Westinghouse Electric & Mfg. Co., of East Pittsburg, Pa., where he was employed with the Railway Power and Industrial Division until 1913, when he went to the Crocker-Wheeler Co. as assistant chief engineer, later becoming manager of the small motor department.

JOHN M. DAVIS, who has been president and a director of Manning, Maxwell & Moore, Inc., 100 E. 42nd St., New York City, dealers in machine tools and supplies, for several years, has been elected president of the Delaware, Lackawanna & Western Railroad, assuming office July 1. Mr. Davis came into the machine tool business from the railroad field. In his early days he was with the Erie Railroad and the Great Northern Railroad. For seven years he was general superintendent of the Union Pacific and the Southern Pacific Railroads; later he was manager and general manager of the Baltimore & Ohio Railroad for six years, including two years as vice-president in charge of maintenance and operation.

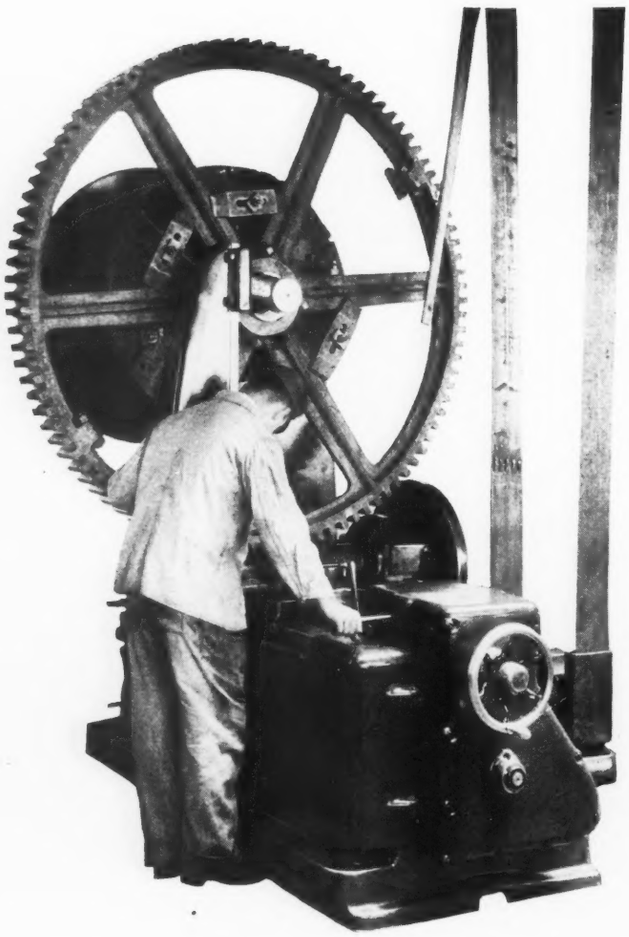
CHARLES N. RING, until recently works manager of the Allied Steel Castings Co., Harvey, Ill., has been appointed assistant director of the Electric Steel Founders' Research Group, succeeding W. J. CORBETT, who recently resigned to become secretary-manager of the Steel Founders' Society of America. Mr. Ring has had more than fifteen years' experience in steel casting manufacture, following his education at the Washington University and the University of Missouri. Prior to his connection with the Allied Steel Castings Co., Mr. Ring was connected with the American Steel Foundries, the Commonwealth Steel Co., the Illinois Steel Co., the Laclede Steel Co., and the Ohio Steel Foundry Co. He is active in the affairs of the American Foundrymen's Association and the American Society for Testing Materials.

* * *

IMPORTANCE OF IRON AND STEEL SCRAP

Iron and steel scrap is a far more important factor in steel-making than is generally realized. The utilization of scrap is as old as the iron industry itself, but the extensive use of it and the collecting of scrap on a commercial basis began only with the rapid development of the open-hearth process of steel manufacture. The scrap business has grown since that time to a trade comparable to any of the basic raw-material producing industries. According to *Commerce Monthly*, there are approximately 3000 scrap iron yards in the United States, employing about 50,000 workers, in addition to 150,000 scrap collectors who depend upon this occupation for a livelihood. All commercial scrap iron has to be sorted and properly graded before it can be used to advantage in the iron and steel industry. About one-fourth of the scrap supply is obtained from the railroads, from 35 to 40 per cent is industrial or shop scrap obtained from metal-working shops of all kinds, and the remaining 35 per cent is derived from the miscellaneous collections obtained by scrap iron yards. Thus over one-third of our scrap iron supply is collected by the junk-man who disposes of his accumulation each day for cash so that he can carry on his trade the following day. Few realize what an important part the junk-man plays in our iron and steel industry.

For High Production and L



—use Brown & Sharpe Automatic Gear Cutting Machines for accurate gears at low costs. They are built to stand coarse feeds and fast speeds and to turn out smoothly finished, accurate gears.

Easy to operate, with low upkeep expense, they will go far toward reducing the cost of your gears.

Send for Catalog No. 138

B·S

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

Special Features Which Are Readily Applied

Automatic Feed Change Mechanism for Double Cutters
Automatic Feed Stop Attachment
Internal Gear Cutting Attachment
Quill Gear Cutting Attachment

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Low Operating Costs

—use Brown & Sharpe High Speed Steel Gear Cutters.

They are made from high quality steel and designed to stand up to the stiffest feeds. Their economy consists in their durability and capacity to hold their cutting edges under the daily drive of a production schedule.

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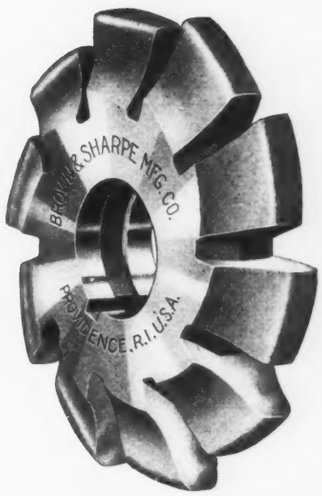
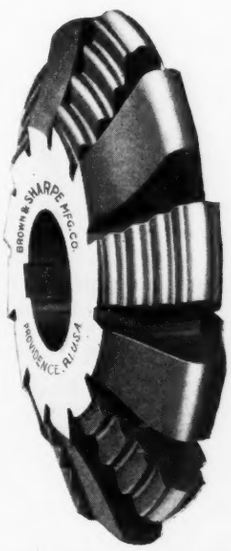




Improved Stocking Cutter

By using this type of cutter ahead of the finishing cutter heavy cuts at fast speeds and coarse feeds can be taken.

SHARPE

Do you know about Brown & Sharpe Ground-Form Gear Cutters? They produce gears of high accuracy and also increase production by their free cutting action. We can supply them for pitches from 1¾ to 12, inclusive.

You should have a copy of our booklet on Ground-Form Cutters.

OBITUARIES

ANDREW W. FOOTE

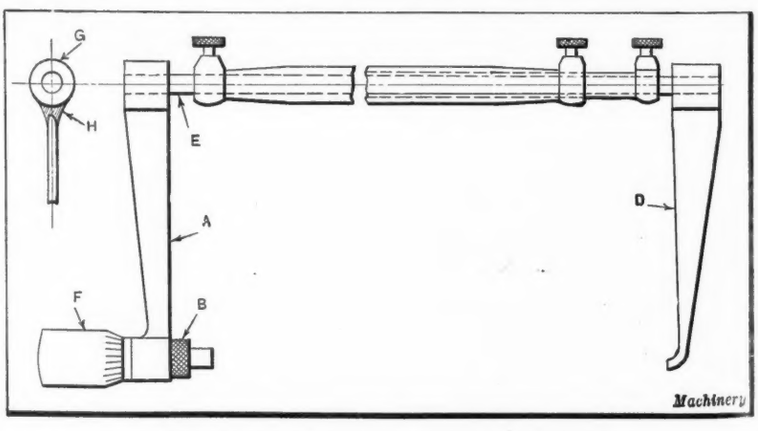
Andrew Ward Foote, founder of the Foote-Burt Co., Cleveland, Ohio, died June 3 at his home in Cleveland. He was born in Guilford, Conn., October 5, 1865. When he was seventeen years old, he went to Hartford, Conn., and served a four-year apprenticeship with the Pratt & Whitney Co. In 1887 he went West, and at first entered the service of the Louisville & Nashville Railroad. In 1892 he came to Cleveland and founded the Foote-Burt Co., remaining president of this company until 1919, when failing health led him to retire from active business. For many years Mr. Foote took an active part in the affairs of the National Metal Trades Association, and for four years served as a member of the Administrative Council of the association. He had been president of the Cleveland branch of the association for the last seven years, and also a director of the Electric Controller & Mfg. Co. of Cleveland. He had been a member of the American Society of Mechanical Engineers since 1900, and was a member of many Cleveland clubs. In 1892, he was married to Winifred Burt of Cincinnati, who, with their daughter Katharine, survives him.

ALBERT J. JONES, secretary and general manager of the Acme Machine Tool Co., Cincinnati, Ohio, died suddenly in Cincinnati on May 31. Mr. Jones was born in Cincinnati forty-two years ago, and had been secretary and general manager of the Acme Machine Tool Co. for the last thirteen years. Prior to that he was connected with the Lodge & Shipley Machine Tool Co. for seven years. He was known as a man of excellent business ability and of pleasing personality, and was well known in machinery circles. He took an active interest in the work of the National Machine Tool Builders' Association, and was chairman of the turret lathe committee of that organization. His sudden death was a great loss to his company. He is survived by his wife and two children.

CALIPERS WITH TELESCOPIC FRAME

By H. K. GRIGGS

The writer read with interest the article pertaining to the adjustable-frame calipers which appeared on page 639 of April MACHINERY, and would like to suggest the following changes in the design. If the legs *A* and *D* are turned around so that the straight sides face each other as shown in the accompanying illustration, the calipers can be used for wider work. Another change would be to secure the leg *A* to a rod *E* and have the lower end of *A* equipped with a small micrometer *F*. A fine thread may be cut at the end of the micrometer cylinder and a knurled nut *B* provided to secure the micrometer in place. A convenient method of constructing the legs *A* and *D* is to cut the body pieces from 1/4-inch steel plate with a cutting torch, and weld these pieces to round-head members such as shown at *G*. The method of joining the two members by oxy-acetylene or electric welding is indicated at *H*.



Telescopic Frame Calipers with Micrometer Adjustment

REDUCING COSTS BY STANDARDIZATION

In an address by O. B. Zimmerman of the International Harvester Co., on the subject of standardization, the advantages gained by a carefully planned standardization program are summarized as follows:

1. It establishes a minimum and uniformly graded series of materials, both raw and semi-finished, which will meet the manufacturer's requirements according to the products and processes given preference.

2. It results in savings due to uniformity and speed in manufacture with the minimum variety and number of processes. It reduces manufacturing supervision.

3. It results in reduction of inventories in both materials and manufacturing equipment. This carries with it simplified clerical work all along the line.

4. Important reductions in labor costs, in both manufacture and assembly, accrue.

5. Increased speed and uniformity in designs result also. Standardization substitutes group judgment for individual judgment. It reduces experimental work and try-outs, and assures sensible graded sizes. It reduces the percentage of time taken on designs or on details. The saving can be better devoted to the more important general problems. This has a wholesome effect on initiative.

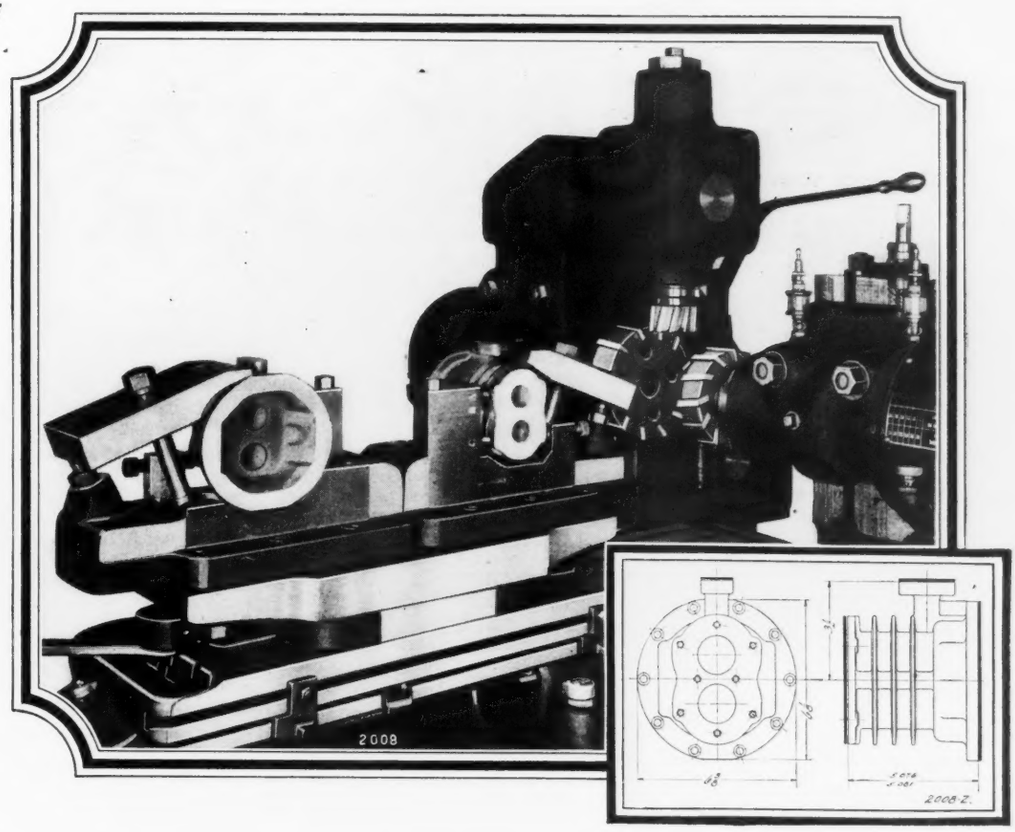
6. Sensible standardization facilitates sales by pleasing customers. It furnishes effective and convincing argument. It warrants higher prices, since it raises the quality of the product. It reduces sales resistance. Repair stocks and handling charges are also reduced.

7. It reduces needless waste from every angle.

* * *

SUMMER MEETING OF AUTOMOTIVE ENGINEERS

At the summer meeting of the Society of Automotive Engineers, held at White Sulphur Springs June 16 to 19, special sessions were held relating to noise investigation, lubrication, fuel utilization, highway safety, gasoline-electric buses and rail-cars, research, brake design and transmissions. Among the papers may be mentioned "Automobile Noise Measurement," by H. C. Snook, Bell Telephone Laboratories, Inc.; "Oil Flow in Complete Journal Bearings," by D. P. Barnard, 4th, Standard Oil Co. of Indiana; "Requirements in Rail-car Design," by C. O. Guernsey, J. G. Brill Co.; "An Electric Drive for Gasoline Buses," by H. S. Baldwin, General Electric Co.; "Fundamentals of Brake Design," by O. M. Burkhardt, Research Manager, Society of Automotive Engineers; "Development of a Modern Four-wheel Mechanical Braking System," by J. R. Cautley and A. Y. Dodge, Bendix Brake Co.; "Hydraulic Brakes, Their Application and Development," by H. E. Maynard, Maxwell Motor Co.; "Recent Work on Unconventional Transmissions," by P. M. Heldt, *Automotive Industries;* and "A Study of the Probable Sources of Transmission Noise," by Earle Buckingham, Niles-Bement-Pond Co. As usual, at the summer meeting of the Society of Automotive Engineers, the social events were given considerable prominence.



THREE HEADS ARE BETTER THAN ONE

Milling three surfaces at once on a 24″ Automatic Duplex Cincinnati Miller is an excellent example of replacing obsolete equipment. A standard duplex machine is equipped with an additional special vertical head.

One cylinder block is held in a special fixture mounted at the ends of the index base (operator loads one piece while the other is being milled).

Simple standard cutters are used. Since all surfaces are milled at one setting, accurate relationship between the milled surfaces is obtained. Production is decidedly increased because *three surfaces are milled at once.*

This is one of hundreds of installations recommended and installed by our Service Department. Since we manufacture 38 sizes and types of machines, we are in a position to recommend for you the *right* machine for your job—Automatic Millers—Knee and Column Millers—the *right* Machine.

THE CINCINNATI MILLING MACHINE COMPANY
CINCINNATI, OHIO

CINCINNATI MILLERS

TRADE NOTES

MODERN TOOL & MFG. CO., Cincinnati, Ohio, moved on June 1 from 121 Opera Place to larger quarters at 222 Post Square.

DELTA STAR ELECTRIC CO. is adding a new unit to its factory at Campbell Ave., Chicago, Ill. The contract has been awarded to the Austin Co. of Cleveland, Ohio.

AMERICAN MANGANESE STEEL CO., INC., Chicago Heights, Ill., has just placed in operation at Los Angeles, Cal., a new foundry for the manufacture of "Amsco" manganese steel castings.

METAL SALES CO., 511 Bergen Ave., Jersey City, N. J., has been appointed national distributor for Crilly mercury bearing metal, made by the Crilly Mercury Metal Corporation of New Jersey.

REPUBLIC FLOW METERS CO. announces the opening of a branch office in Cleveland, Ohio, at 617 Engineers Building. L. C. Wilson, formerly of the Pittsburg office, will be in charge of the new branch.

GODDARD & GODDARD CO., INC., Detroit, Mich., manufacturer of milling cutters, has appointed H. S. Huncke, 25 S. Jefferson St., Chicago, Ill., representative of the company for the northern Illinois and Wisconsin territory.

UNITED STATES ELECTRICAL TOOL CO., Cincinnati, Ohio, has appointed the Backmeier Sales Corporation, Cincinnati, Ohio, manufacturer's agent to handle and promote the sale of United States electrical tools in the southern states.

UEHLING INSTRUMENT CO., Paterson, N. J., has appointed Charles M. Bullard, 912 Washington St., Appleton, Wis., as representative of the company for central and northwestern Wisconsin, to handle the "Apex" CO_2 recorder and other power plant instruments.

RUSSELL-BURDSALL & WARD CO., Portchester, N. Y., manufacturer of bolts, nuts, and rivets, has placed a contract with the Austin Co. of Cleveland, Ohio, for the construction of an addition to its plant. The extension will comprise a one-story steel frame structure.

FOOTE BROS. GEAR & MACHINE CO., 232-242 N. Curtis St., Chicago, Ill., has made arrangements with the McBurney Stoker & Equipment Co., 619 Trust Co. of Georgia Building, Atlanta, to take charge of the sale of the IXL line of speed reducers and general gear products in the state of Georgia.

CHASE COMPANIES, INC., Waterbury, Conn., announce the removal of the New York offices of the Chase Metal Works and the Waterbury Mfg. Co. to 138 Lafayette St., New York City, on July 1. Complete stocks of Chase brass in sheet, rod, wire, and tubing will be carried at the new location.

SLEEPER & HARTLEY, INC., 335 Chandler St., Worcester, Mass., has taken over the line of spring and wire coiling machines formerly manufactured by the Garvin Machine Co. of New York, and is prepared to offer similar as well as improved machines, together with all the necessary repair and supply parts.

KEMPSMITH MFG. CO., Milwaukee, Wis., manufacturer of milling machines, announces that the directors have elected the following officers: Edwin Wollaeger, president; John Goetz, vice-president, chairman of the board of directors, and general manager; F. Wollaeger, Jr., treasurer; and Edward Leason, secretary.

REED-PRENTICE CO., Worcester, Mass., announces the appointment of the Stocker-Rumely-Wachs Co., 117 N. Jefferson St., Chicago, Ill., as exclusive representative in the Chicago territory, which includes northern Illinois, northern Indiana, western Michigan, and eastern Wisconsin, and the states of Iowa and Nebraska.

SIMONDS SAW & STEEL CO., Fitchburg, Mass., has established thirteen saw service stations and repair shops for the accommodation of users of saws and planer knives, in the following cities: Boston, New York, Detroit, Chicago, Memphis, New Orleans, San Francisco, Portland, Seattle, Montreal, Toronto, St. John, N. B., and Vancouver.

STEARNS CONVEYOR CO., Cleveland, Ohio, has opened a new branch office in Kansas City, Mo., at 3233 Roberts St. Larger quarters have also been taken in the New York district at 935 Singer Building, New York City, to facilitate sales work. R. J. Hanna has been placed in charge of the Kansas City office. The company also announces that it has taken over the general distribution in the United States of the Messiter conveyor scales.

LUMEN BEARING CO., Buffalo, N. Y., states that the recent announcement of the sale of the Lumen Bearing Co. of Youngstown, Ohio, to the Falcon Bronze Co. of that city, has raised the question of the Buffalo company's relation to the Youngstown corporation, and desires to make it clear that this sale does not change the status of the Lumen Bearing Co. of Buffalo, which is a separate and distinct New York State corporation.

CHAIN BELT CO., Milwaukee, Wis., states that a recent survey made by the company shows a decided tendency toward the increased use of chain drives and sprocket wheels in modern industry, and especially a tendency toward the increased use of sprockets cast in a chill so as to harden the teeth and the rim of the sprockets, this method lengthening both the life of the sprocket wheel and, by decreasing the wear, the life of the chain as well.

ECONOMY DRAWING TABLE & MFG. CO., Adrian, Mich., has disposed of its drafting-room business to the Hamilton Mfg. Co., of Two Rivers, Wis. A new company has been formed consisting of a copartnership of H. E. Smith, president and general manager, R. G. Manning, vice-president, and M. M. Straub, secretary and treasurer, which will be devoted to the manufacture of school equipment, such as art and mechanical drawing-room tables, cases, etc. This business will be carried on at the plant at Adrian.

WADE-AMERICAN TOOL CO., Waltham, Mass., announces that the company will be known in the future as the WADE TOOL CO. At the time of the merging of the American Watch Tool Co. with the business of Walter H. Wade in 1918, the name Wade-American Tool Co. was adopted to indicate the merger of the two old companies. This purpose having been served for a sufficient period, the shorter and more convenient name will be adopted for the future. The manufacture of bench lathes and precision machinery carried on by the company will be continued as in the past.

THOMSON ELECTRIC WELDING CO., Lynn, Mass., announces a number of changes in its district offices. The Chicago office has been moved from 817 W. Washington Blvd., to 514 Machinery Hall, 549 W. Washington St. The company has discontinued its connection with the English & Miller Machinery Co., Detroit, Mich., and is now represented in Michigan by James A. Muir, Room 2-213, General Motors Bldg., Detroit. The Cincinnati sales office has been discontinued, and a new office is to be opened in Cleveland, Ohio, 852 Leader Bldg. The New York office at 50 Church St. has been moved from Room 1577 to Room 1273.

CHESTERFIELD METAL CO., Detroit, Mich., has recently purchased the plant formerly occupied by the Nelson-Blanck Mfg. Co., 7742 Dubois St., Detroit, Mich. In moving from its old plant at 261 St. Aubin Ave. to this new location, the Chesterfield Metal Co. will obtain substantially increased manufacturing facilities. The furnace department will have double the melting capacity of the old plant, and in addition, a fully equipped department for grinding alloy metals has been provided, so that such products as inserted teeth for milling cutters and other tools may be produced complete in the plant, ready for delivery to customers.

NATIONAL AUTOMATIC TOOL CO., Richmond, Ind., has purchased the line of duplex drills formerly made by the Garvin Machine Co., of New York City. The INDUSTRIAL PLANTS CORPORATION, 25 Church St., New York City, has purchased the Garvin line of plain and universal milling machines. The FREW MACHINE CO., 124 W. Venango St., Philadelphia, Pa., has purchased from the Garvin Machine Co. its line of hand milling machines, both belt- and motor-driven; screw-slotting machines; hand lathes; cam-cutting machines; air cylinders; and profiling machines. All these companies are in a position to supply repair parts for the lines purchased.

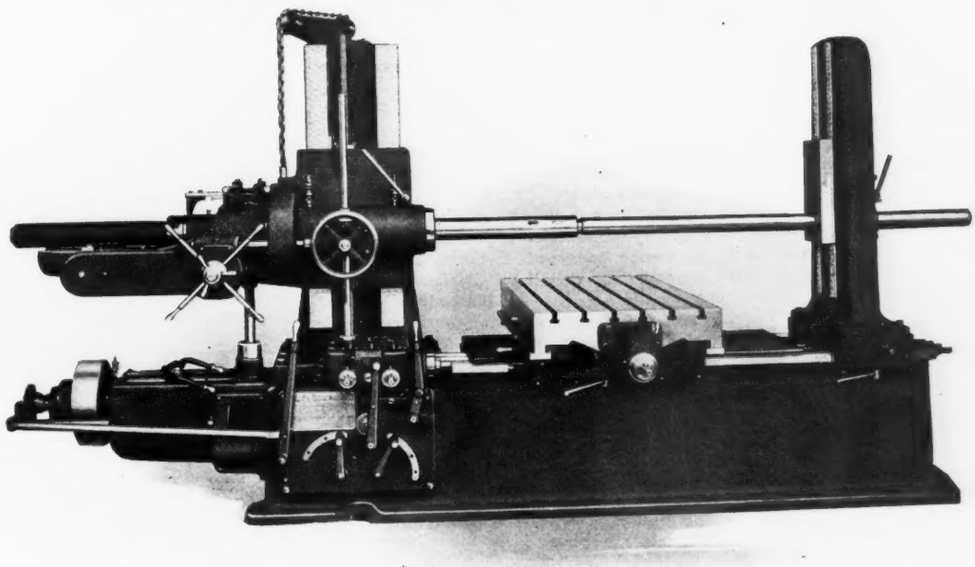
GOGAN MACHINE & FOUNDRY CO., INC., 1630 Collamer Ave., Cleveland, Ohio, has been organized to manufacture machines for forming and heat-treating automobile springs and bumpers, automobile and coil spring testing machines, automatic hardness testing machines, and special machines in general. Joseph Gogan, for seven years general superintendent of the Detroit Steel Products Co. and for two years general manager of the McCann-Harrison Corporation of Cleveland, manufacturer of automatic heat-treating equipment, is president. Part of the McCann-Harrison business has been acquired by the Gogan Machine & Foundry Co., Inc. Mr. Gogan's brother, Charles Gogan, a mechanical engineer, is vice-president, and H. I. Mathews is secretary and treasurer.

* * *

According to *Commerce and Finance*, it has been estimated that the electrification of one-half of the railroad mileage of the United States would result in a saving of $120,000,000 annually in the railroads' coal bill. Undoubtedly, where water power is available without involving too expensive construction problems for the hydro-electric power station, electric power can be produced with a considerable saving, as compared with the use of steam locomotives, but whether, all factors considered, the railroads could generally be operated cheaper electrically is still considered by many engineers to be an open question.

THE LUCAS "PRECISION"

Horizontal Boring, Drilling and MILLING MACHINE



A PROFITABLE INVESTMENT

Not an Expense

Where there is work for which it is adapted —and that applies to almost every machine shop—it will be paid for whether installed or not.

Work done by other means—inaccurately and less efficiently—costs enough extra to pay for the "LUCAS" many times over during its lifetime.

Have the "PRECISION" to show for the money!

WE ALSO MAKE THE

LUCAS POWER Forcing Press

THE LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo.

COMING EVENTS

AUGUST 18-20—Twenty-ninth annual convention of the International Railroad Master Blacksmiths' Association in Cleveland, Ohio; headquarters, Hotel Winton. Secretary, W. J. Mayer, 2347 Clark Ave., Detroit, Mich.

SEPTEMBER 8-11—Machine Tool Exhibition in the Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. H. R. Westcott, chairman, 400 Temple St., New Haven, Conn.

SEPTEMBER 14-18—Annual convention of the American Society for Steel Treating, and Seventh National Steel Exposition, to be held at the Public Auditorium, Cleveland, Ohio. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

SEPTEMBER 14-19—Radio Fair to be held at the 258th Field Artillery Armory, New York City. For further information write Calvin Harris, Hotel San Remo, New York City.

SEPTEMBER 15-16—Production meeting of the Society of Automotive Engineers at Cleveland, Ohio. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

SEPTEMBER 28–OCTOBER 3—Tenth exposition of chemical industries at Grand Central Palace, New York City.

OCTOBER 5-9—Annual convention of the American Foundrymen's Association at Syracuse, N. Y. An exhibition of foundry and machine shop equipment and supplies will be held in connection with the convention.

NOVEMBER 30–DECEMBER 5—Fourth national exposition of power and mechanical engineering to be held in the Grand Central Palace, New York City.

NEW BOOKS AND PAMPHLETS

INSTRUCTIONS FOR CARE AND OPERATION OF TRANSFORMERS. 16 pages, 6 by 9 inches. Published by the Electric Power Club, B. F. Keith Bldg., Cleveland, Ohio. Price, 25 cents.

POWER SWITCHBOARD AND SWITCHING EQUIPMENT HANDBOOK. 95 pages, 6 by 9 inches. Published by the Electric Power Club, B. F. Keith Bldg., Cleveland, Ohio. Price, 50 cents.

REPORT ON THE FIRST PAN-AMERICAN CONFERENCE ON UNIFORMITY OF SPECIFICATIONS. 103 pages, 6 by 9 inches. Published by the Central Executive Council of the Inter-American High Commission, Washington, D. C. Printed in both English and Spanish.

THE EFFECT OF TEMPERATURE UPON THE PROPERTIES OF METALS. 184 pages, 6 by 9 inches. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. Price, single copies up to ten, $1.50; in lots of ten to fifty, $1 per copy; in lots of fifty to one hundred, 75 cents per copy.

STANDARDS OF THE HYDRAULIC SOCIETY. 34 pages, 6 by 9 inches. Published by the Hydraulic Society, 90 West St., New York City.

This book contains the recommended standards of the Hydraulic Society for 1925, including the principles of business conduct approved by the society, and standards pertaining particularly to the design and operation of pumps.

AUTOMOBILE STARTING, LIGHTING, AND IGNITION SYSTEMS. By Victor W. Page. 892 pages, 5 by 7½ inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

This is a revised and enlarged edition of a book covering automobile starting, lighting, and ignition systems, including storage battery construction, care, and repair. The leading systems used on popular makes of cars are described and illustrated, and a large number of wiring diagrams are shown. The book has been written with special reference to the requirements of the non-technical reader. Elementary electrical principles are considered before the features of the various systems are described, and the basic principles are illustrated with simple diagrams.

ENGINEERING INDEX FOR 1924. 711 pages, 6½ by 9¼ inches. Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City. Price, $7 (to members of the society, $6).

This is the 1924 edition of an annual index covering the entire field of engineering literature, including periodicals, reports, and other publications, both American and foreign. The present volume contains over 17,000 carefully selected items. A list of the periodicals indexed is given at the beginning of the book. The various articles are classified by subject, and a brief statement of the contents of the articles is given, as well as reference to the volume, date, and page numbers of the periodicals in which the article appeared. An important service rendered in connection with the index is the supplying of photostatic copies of any of the articles listed.

PRACTICAL DESCRIPTIVE GEOMETRY. By William Griswold Smith. 281 pages, 6 by 9 inches; 190 illustrations. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $2.50.

This is the third edition of a book on descriptive geometry. Professor Smith is well qualified for the preparation of a work of this kind, being associate professor of mechanical engineering and head of the drafting department of the College of Engineering, Northwestern University. The third edition was prepared primarily for the purpose of thoroughly revising the exercises intended for class use. At the same time a slight rearrangement of the chapters has been made, and these changes, with a few eliminations and additions, constitute the chief differences in the text from earlier editions. A large number of new illustrations have also been introduced.

MODEL MAKING. Edited by Raymond Francis Yates. 428 pages, 5½ by 8¾ inches. Published by the Norman W. Henley Publishing Co., 2 W., 45th St., New York City. Price, $3.

This book is devoted to the subject of model making, including work-shop practice and the design and construction of models. It does not describe the construction of toys. The first part of the book treats of the mechanical sciences and processes related to model engineering and mechanics in general, including lathe work, pattern work, electroplating, soldering, grinding, drilling, etc. This is followed by descriptions, with illustrations, of complete models made by some of the leading model engineers in the country, including steam engines, boats, guns, locomotives, cranes, etc. The aim is to instruct the inexperienced workman in making models, and to give to the experienced mechanic helpful hints and shortcuts.

THE METALLURGY OF ALUMINUM AND ALUMINUM ALLOYS. By Robert J. Anderson. 913 pages, 6 by 9 inches. Published by Henry Carey Baird & Co., 2 W. 45th St., New York City. Price, $10, net.

The dearth of information on the metallurgy of aluminum and light aluminum alloys has been keenly felt by workers in the field, and it is the author's belief that there is an urgent need for such a book as he has endeavored to supply. An attempt has been made throughout to attack the subject from the point of view of the metallurgical engineer concerned in the production of aluminum and aluminum alloys in raw and manufactured form, rather than from either the academic or too practical point of view. The treatment is comprehensive, the subject being covered from the mining of the ores to the fabrication of the metal, including its applications and uses. The information presented should be useful not only to metallurgical engineers and foundrymen, but also to automotive and mechanical engineers and others interested in specific applications of this metal and its alloys. The work is also intended to serve as a text for metallurgical courses in colleges and universities.

PRINCIPLES OF MACHINE DESIGN. By C. A. Norman. 710 pages, 6 by 9 inches; 585 illustrations. Published by the Macmillan Co., 64 Fifth Ave., New York City. Price, $6.50.

The author of this book, who is professor of machine design at the Ohio State University, has prepared this volume primarily as a textbook for engineering schools. He mentions in the preface that if such a work is to serve the immediate purpose for which it is intended, its main business must be to supply practical rules and to record good design. The book covers, therefore, the whole field of machine design in such a manner as to impart to the engineering student a fair general knowledge of the entire subject. Following the opening chapters on the strength and failure of materials, the subjects dealt with include riveting and welding; boilers and plate vessels; bolts and screws; force and shrink fits; hydraulic cylinders; cylinders and cylinder heads for steam and gas engines; stuffing-boxes and packings; pistons and piston-rings; leaf springs; coil springs; piston-pins, connecting-rods, and cross-heads; cranks and crankshafts; flywheels; spur gearing; helical gearing; bevel gears, worm-gears and spiral gears; belting; pulleys; rope driving; chains; friction drives; wire rope and hoisting; plain bearings; ball bearings; roller bearings; shafts and shafting; permanent couplings; clutches; brakes; high-speed disks; and piping.

NEW CATALOGUES AND CIRCULARS

HEATING SYSTEM. American Blower Co., Detroit, Mich. Circular outlining the "Venturafin" method of heating factories, garages, and other buildings.

RIVETERS. Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. Bulletin R-205, illustrating and describing Hanna compression yoke riveters.

VISES. Prentiss Vise Co., 106 Lafayette St., New York City. Catalogue of Prentiss vises, illustrating the particular features of these vises, and giving prices of the various styles.

STEEL PIPE FLANGES. American Spiral Pipe Works, Box 485, Chicago, Ill. Circular announcing the publication of an 88-page catalogue covering the company's products of forged steel pipe flanges.

BEARINGS. Hill Clutch Machine & Foundry Co., Cleveland, Ohio. Bulletin 112, descriptive of the Cleveland type collar oiling bearing, which has the advantage of a positive oil feed and distributing system.

RECORDING THERMOMETERS. Bristol Co., Waterbury, Conn. Catalogue 1303, illustrating and describing Bristol gas-filled recording thermometers for temperatures between 60 degrees below zero and 1000 degrees F.

ANTI-FRICTION BEARING METALS. Metal Sales Co., 511 Bergen Ave., Jersey City, N. J. Leaflet entitled "A Message about Bearing Metals," outlining the characteristics of Crilly mercury anti-friction bearing metal.

INTAKE SCREENS. Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. Book No. 752, descriptive of the general construction of Link-Belt "clean water" intake screens, showing a large number of installations of these screens.

SPEED REDUCERS. Falk Corporation, Milwaukee, Wis. Bulletin 38, descriptive of the line of small herringbone speed reducers made by this company in single, double, and triple reductions for any horsepower and speed.

4 Reasons Why WETMORE Reamers Cut Production Costs

Wetmore Expanding Six-blade Standard Finishing Reamer with arbor integral.

Production men in many of the largest plants are specifying Wetmore Expanding Reamers because Wetmores have proved —on actual tests—that they do *better, more accurate work at less cost.* Here are four features that make Wetmore the reamer preferred by men who know what it can do:

Adjustments to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made. Cone nut and expansion screw keep blades always parallel with axis.

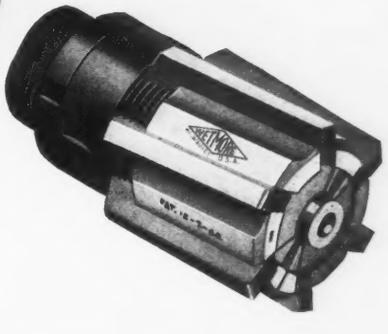
Solid alloy steel body, heat-treated, guaranteed against breakage.

Left Hand Angle Cutting Blades that prevent digging in, chattering and scoring while backing out. Shearing effect of blades increases life of cutting edge.

No grinding arbor required for regrinding. Wetmore Reamers can be reground on their original centers.

Wetmore Expanding Six-blade Standard Finishing Reamer with arbor separate.

Wetmore Blades are carried in stock for all types of Wetmore Reamers. Best high-speed steel, ground to thickness, length, and on seat. In ordering, give type and size of reamer and whether reamer is to be used on steel, cast iron, or bronze, etc.



Give a Wetmore Reamer a trial on a good stiff job and compare its work with that of reamers you've been using. You be the judge—and we'll rest our case with you.

Write for catalog of full line of standard, heavy-duty, shell, small machine and cylinder reamers, arbors, replacement blades. Sent FREE—postpaid.

WETMORE REAMER CO.

MILWAUKEE, WISCONSIN

WETMORE EXPANDING REAMERS

"THE BETTER REAMER"

PLATE VALVES. Mesta Machine Co., Pittsburg, Pa. Bulletin D, treating of Mesta automatic plate valves of the Iversen patent. These valves are applicable to air and gas compressors, blowing engines, ammonia compressors, vacuum pumps, etc.

MOTORS. General Electric Co., Schenectady, N. Y. Bulletin 41521B, dealing with high-speed induction motors and frequency changers, adaptable for application on machine tools requiring a high-speed drive and on high-speed woodworking machines.

SPRING MAKING AND WIRE WORKING MACHINERY. Sleeper & Hartley, Inc., 335 Chandler St., Worcester, Mass. Leaflet illustrating typical examples of the line of automatic spring making and wire working machinery manufactured by this concern.

STEEL. Carnegie Steel Co., Pittsburg, Pa. Standard specifications for steel for bridges and buildings, locomotives and cars, boilers and rivets, commercial and forging bars, reinforcement bars, forgings, railway and industrial wheels, axles, and shafts.

TURRET LATHES. Foster Machine Co., Elkhart, Ind. Folder illustrating and describing tooling equipment for machining differential housings on turret lathes, giving information in regard to savings obtainable through the use of the equipment described.

ARC WELDING APPARATUS. General Electric Co., Schenectady, N. Y. Bulletin 48937.1 entitled "Automatic Arc Welding," pointing out the uses and value of automatic arc welding, and describing the welding apparatus and generating equipment used.

ELECTRIC DRILLS. Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 107, illustrating the features of construction of the new Hisey standard-duty ½-inch universal electric drill. The leaflet also shows various types of electric grinders made by the company.

STAINLESS STEEL AND IRON. American Stainless Steel Co., Commonwealth Bldg., Pittsburg, Pa. Circular entitled "Solid Facts About Stainless," outlining the advantages of stainless steel in the home and in industry. A large number of applications of stainless steel are listed.

MOTORS. Wagner Electric Corporation, St. Louis, Mo., is distributing to the trade a calendar for the year May, 1925, to May, 1926, designed to show three months at a glance. The calendar carries a list of the company's products which include electric motors, transformers, and fans.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Sheets Nos. 10 FE and 18 FE for loose-leaf catalogue, illustrating the application of New Departure double-row ball bearings in centrifugal separator baskets and electrically driven polishing heads. New price lists have also been issued.

CHUCKS. Thomas Elevator Co., 24 S. Hoyne Ave., Chicago, Ill. Catalogue 3, descriptive of the Barker wrenchless chuck. The pamphlet describes how this chuck is assembled, and shows views of the various component parts. Complete specifications are included for both the two- and three-jaw chucks.

GRINDING MACHINES. Builders Iron Foundry, Providence, R. I., and its associate, the Diamond Machine Co., have issued a catalogue describing a new line of belt- and motor-driven ball-bearing grinders and polishing machines and swing-frame grinders. Copies may be obtained by those interested upon request.

JIG BUSHINGS. Ex-Cell-O Tool & Mfg. Co., 1469 E. Grand Blvd., Detroit, Mich. Circular illustrating and tabulating the standard jig bushings manufactured by the company, and listing three extra lengths that have been added on all types of jig bushings made by the company, for services where extra long bushings are required.

TWIST DRILLS. Detroit Twist Drill Co., Detroit, Mich. Booklet entitled "The Drill for Today and its Evolution." This book contains an illustrated description of the different methods used for producing drills, including drills with milled flutes, forged drills, and rolled drills. Information is also given on such subjects as angle of twist and strength of drills.

SPECIAL MACHINERY. Dodge Mfg. Corporation, Mishawaka, Ind., has published a book visualizing, by means of full-page illustrations, the engineering, foundry, and machine shop facilities of the company, which are available for the manufacture of special machinery and equipment. The book also shows the wide range of special equipment built.

GEARS. Poole Engineering & Machine Co., Woodberry, Baltimore, Md. Pamphlet illustrating and describing how Poole machine-molded gears are made. The molding machine used is described, as are also the various steps in the process of making the gears. By this method, gears of a great variety of sizes can be produced, ranging from 1 inch to 65 feet in diameter.

GEARS. Boston Gear Works Sales Co., Norfolk Downs, Mass. Circular entitled "Why It Pays to Standardize," outlining the advantages of standardized gears and illustrating a few of the 3000 sizes of standardized Boston gears carried in stock for immediate delivery. The circular also illustrates an application of the Renold-Boston silent chain drive in a large textile mill.

TURRET LATHES. Warner & Swasey Co., Cleveland, Ohio. General catalogue illustrating and describing in detail the line of turret lathes made by this company. The catalogue is divided into five sections, dealing with the following types: universal hollow hexagon turret lathes, universal turret lathes, turret lathes with pan and pump, plain set-over and forming turret lathes, and brass working machine tools.

TWIST DRILLS. Cleveland Twist Drill Co., Cleveland, Ohio. General catalogue No. 41, covering the Cleveland line of high-speed twist drills, reamers, screw extractors, countersinks, counterbores, arbors, mandrels, sockets, mills, etc. The catalogue has been provided with a thumb-index for convenient reference. A new feature is a section of mechanical data related to drilling practice.

MACHINE TOOLS. Joseph T. Ryerson & Son, Inc., Chicago, Ill. Catalogue known as Section 4, covering machine tools and metal-working equipment for general manufacturing purposes, including machine shops, boiler shops, structural shops, railroad shops, repair shops of all kinds, steel mills, etc. This catalogue, containing 128 pages, illustrates and describes the varied line of machine tools built and sold by the company.

CRANES AND HOISTS. Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin 80, entitled "Shepard Equipment for the Iron and Steel Industry," illustrating and describing equipment built by the company, and showing its direct application in the iron and steel field. In connection with each crane and hoist shown, there is a concise description together with one or more photographs of actual installations.

BENCH LATHES, MILLING MACHINES, DRILL PRESSES, AND TAPPING MACHINES. Rice Machine Tool Corporation, 351-365 Sixth Ave., Newark, N. J. Catalogue illustrating and describing the Sloan & Chace line of precision tools, which include bench lathes and attachments, bench milling machines, automatic gear and pinion cutters, bench drill presses and tapping machines, countershafts, and jigs, fixtures, and dies.

GEARING. Niles-Bement-Pond Co., 111 Broadway, New York City. Catalogue of Maag gears, illustrating and describing installations, and containing information on methods of generating Maag gears, the differences between these and standard gears, the tooth form in comparison with other tooth forms, strength, sliding action, life, noiselessness, length of active profile, and other features of the gears. Maag gears can be made in the spur, helical, and herringbone types.

PNEUMATIC DIE CUSHIONS. Marquette Tool & Mfg. Co., 321 W. Ohio St., Chicago, Ill. Booklet entitled "Short Cuts in Metal Drawing," showing various examples of work that has been done on presses equipped with Marquette pneumatic die cushions. The sheet-metal drawing and forming operations illustrated are performed on all makes of presses, and cover both large and small work. Copies of this booklet will be sent to those interested upon request.

DRILLING MACHINES. Avey Drilling Machine Co., Cincinnati, Ohio. Catalogue of Avey sensitive drilling machines, containing illustrations, descriptions, and specifications for each type and size of machine built. The catalogue is so arranged that its different sections comprise units containing complete information on one type of machine, so that either the complete catalogue or the specifications relating to one type only may be sent to prospective purchasers, as desired.

BELTING. Chicago Belting Co., 127 N. Green St., Chicago, Ill. Pamphlet and folders dealing with leather belts in paper and pulp mills; in cement plants; in the mining industry; in quarries and brick plants; in steel mills; in machine shops; and in saw mills. Also folders dealing with various of the company's products such as "Sea Lion" leather belting, "Reliance" leather belting, "Imperial" leather belting, "White Strip Extra Strong" stretchless leather belting, and "Ambassador" leather belting. Also pamphlet relating to service of the company in supplying belting.

THE RIGHT TO A FIRM NAME

An injunction was recently issued by the Supreme Court of New York, relating to rights in the use of established firm names and names of products well known in the trade. This decision will be of interest to manufacturers in general. The firms involved were manufacturers of hair tonics, but the principles involved are applicable in any line of manufacture. It appears that a firm was established in 1881 making a product known by the family name of the founder. Recently a grandson bearing the same name engaged in the manufacture of a similar product and featured the family name in his business. The Court issued an injunction against the new firm preventing the use of the long established trade designation, even though it was identical with the family name of the manufacturer. It has generally been believed that one cannot be restrained from using one's own name in designating a product made in one's own business. The injunction issued by the Court will be of great interest to the trade on this account, because it shows that one can be restrained from the use of one's own name when it causes unnecessary confusion or when it usurps the established name or business of another.